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A NATURE BOOK FOR YOUNG PEOPLE

Hon. Cordelia Lei

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LONDON: T. FISHER UNWIN.

Bedewed Spider's Web.

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OUR SCHOOL OUT OF DOORS

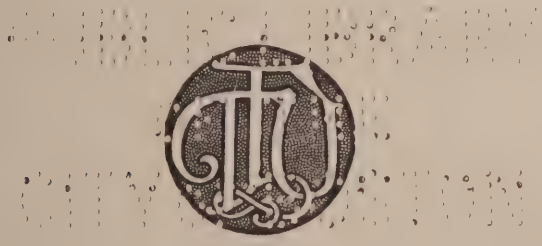
A Nature Book for Young People

By

The Hon. M. CORDELIA LEIGH

Author of

"The Witness of Creation," "Day unto Day uttereth Speech," etc.



LONDON

T. FISHER UNWIN

PATERNOSTER SQUARE

PREFACE

THE following elementary chapters are designed for the assistance of teachers in Nature Study. The writer supposes the teacher to be taking the scholars for a country walk twice a month throughout the year, and to be studying on the spot a subject connected with Nature suitable to the season.

Questions are appended to each chapter which may be found useful for testing in the schoolroom the knowledge gained by the pupils out of doors; and the interest might in some cases be further increased by inviting the student to sketch the objects from Nature or from memory.

The writer takes this opportunity of gratefully acknowledging the kindness of Professor R. Lydekker, Lord Avebury, and Dr Ovenden, Dean of Clogher, who have revised the chapters in MS.

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Our School out of Doors

JANUARY 1

Uniforms for Animals

PROTECTIVE COLOURING.—We all know the reason why our soldiers in the Boer War were put into khaki uniforms; the drab colour did not show up so plainly as other colours against the brown veldt. In many animals we find instances of what are called "protecting colours"; that is, the kind of colours which show up very little against their surroundings, so that the animals are easily hidden from their enemies, or are able to steal upon their prey without being seen.

RATS AND MICE.—Where shall we find animals with protective colours? Can you think of any? Well, there are some which are only too common. You know that rats and mice have dark or grey colours, so that it is not easy to see them at night. It is curious, by the way, that although rats and mice live in the midst of dirt, like all wild animals, they are very clean themselves, and groom and tend their fur with the same care as pussy bestows on her sleek coat.

WEASELS AND STOATS.—If we take a walk on this bright, sunny morning we may come across some small animals astir, and we will think about the clothes they wear.

See there, creeping about among the bushes, glides a weasel. What is the good to it of a long slim body? Well, it can glide easily through the trees because it is so long and thin, and down rabbit holes and up branches. You see that it is pale reddish-brown on its back, sides and legs, and now it is of a lighter colour than in summer, though it does not turn quite white as is often the case in the far North and in Siberia. Probably this colour not only helps to protect it from

Brown Rat

its enemies, but also gives it a better chance of stealing unobserved on the rats, mice and young rabbits which are its prey. It is very active in climbing trees and springing from them upon its quarry. Stoats, as you know, are still larger and fiercer. They are much the same colour as weasels in summer, but are yellowish-white just now, from November to March; and in the North, on the snowy summits of Ben Nevis, for instance, they turn white as if to match the snow. The ermine is the stoat in winter-time. The stoat has always a black tuft on the end of the tail.

HARES.—What was that which scampered across the path and out of sight like a flash of lightning? It was a hare, which lay comfortably in its bed of thick snow a week ago, with a little window scratched in the snow to let in the light; at night it went a-stealing turnips and cabbages in the gardens and farmyards, the large, oblong pupils of its eyes making it well able to see in the dark. Now that the snow has gone its reddish-grey coat helps to keep it well hidden in the dark grey earth, twigs and dead leaves; and if, in spite of all, it is discovered, then it trusts to its long legs to carry it into a place of safety; and it takes sharp turns or "wrenches" to throw its enemies off the scent.

RABBITS.—Its brother rabbit, with whom indeed it does not much keep company, is happy in the cold, though he was a little afraid of starving when the snow seemed likely to cut off his supplies; but he enjoyed himself finely, as you know, gnawing the bark off the trees and bushes with his sharp, curved front teeth, which he shares with other "rodents." Those teeth are sharpened like carpenters' chisels. He lives almost entirely on vegetable substances, and is very fond of the roots of dandelions and docks. I remember a large osier bed on a river bank which was fenced in on the land side to prevent the rabbits from getting in and gnawing the osiers; but one hard winter the river was frozen, and they trotted across the ice and arrived triumphantly in the osier bed after all! When brother rabbit was born he was blind and naked, but he was kept warm by his mother's fur, with which she lined her underground nest. The hare's birthday was in April, and the little leveret was covered with down, and his eyes were open. Thin at first, he became more plump as autumn came on, and he laid in a good store of fat against the winter.

DANGER SIGNALS.—When rabbits and hares want to warn their young that enemies are coming (and their

long sharp ears and bright, watchful eyes quickly tell them of danger), they stamp on the ground, and the whole party at once set off running. It is then that the white patch under their tails shows up plainly, as it does also under the tails of fallow deer when, as we should say of runaway soldiers, they "show the white feather"; and this is supposed to act as a guide to their young to follow them to a place of safety.

SQUIRRELS.—Ah, here is another little rodent enjoying the sunshine! How quiet and motionless it sits, thinking that if it remains still on that branch we shall not notice it! In the late, hard frost it went away and kept snugly in its nest, but now friend squirrel is greatly enjoying the cold bracing air. In a mild autumn it will sometimes neglect to lay up a store in its nest, and simply bury horse chestnuts, etc., in the late autumn in all sorts of queer places, among the roots of rose bushes or in the turf, taking its chance of finding them again when the snow comes. It is very fond of mistletoe berries. You know how, when it is eating nuts, it pierces the shells with its sharp front teeth, carefully removes every fragment of shell, and feeds on the kernel. In winter it has a nice thick fringe of hair on its ears. The nest is made of leaves, moss, etc., twined together, and looks so like the boughs in colour that it is difficult to see it from beneath. The paint brushes called "camel's hair" brushes are really made from squirrels' hairs.

DEER.—See the fallow deer in that dead bracken; how well their coats match its colour, just as the bright tan of the red deer calves matches the dead oak leaves.

HARVEST MICE.—In a corn rick yesterday I noticed a funny little harvest mouse, rather yellow in its upper part and whitish underneath. The harvest mouse only weighs about $\frac{1}{6}$ oz., and is the smallest British mammal but one,—the pigmy shrew is smaller.

You would not find him out in the fields just now, for he burrows or hides in ricks in winter. Next summer he will be hanging his nest of grass and leaves among the corn-stalks, and climbing up to it by means of his long curly tail. He feeds on insects, and has been seen also to eat a worm, which first upset him by twining itself around him!

WATER RATS.—I see over there an animal which

Fallow Deer.

is generally called by a wrong name; you will probably say, "There is a water rat!" but he is really a vole, and not a rat at all. He is very fond of feeding on the pith of water plants, ducktails, etc., but in winter he does not despise turnips or potatoes, as you have probably discovered. He often gets the credit of destroying the fish, but many naturalists say that this is a false charge, and that the common brown rat which sometimes steals down to the water-side and devours fish, as well as land and freshwater snails, is mistaken for the water rat.

The mother water vole will carry her young away in her mouth when threatened with danger, as a cat carries her kittens.

PROTECTIVE COLOURS AMONGST INSECTS AND SPIDERS.—Protective colours are not uncommon amongst spiders and insects which have no other means of protection (as in the green caterpillars, which hide themselves against green leaves), though of course we shall not see many in winter. Those large common "tipulids," a kind of gnat, with brownish bodies and brown markings on their wings, are often difficult to see against the brown earth, and so are some dark speckled spiders. I have seen a whitey-brown moth, called the brown plume moth, which had settled on some rope netting with its head quite bent down and hidden under its body, its legs spread out on a line with the netting, and its second feathery pair of wings quite hidden under the upper pair, which were spread out, giving it the shape of a cross. Had I not been searching the netting very closely for some spiders which I wanted to study, I could never have spied out this little insect.

CATS.—Now that the trees are bare, if you come upon a tabby-cat sitting in a tree on the look-out for birds, you may notice that her general colouring, with her white toes and shirt front, make puss almost invisible a few yards off, when the sunlight plays among the branches and makes lights and shadows.

MIMICRY.—There are certain harmless animals which seem to be protected by looking like harmful ones; this is called "mimicry," though of course they do not know that they are mimics! You probably know the little sun-flies or wasp-flies, which have no sting but appear just like wasps. The drone-fly, by looking like a humble bee, manages to steal into the humble bee's nest and lay her eggs there.

DOVES.—Tame animals, which do not need protection, seem often to put on gayer clothing than their wild relations. The rock dove, for instance, is much more soberly clad than the curiously different fancy pigeons.

A LESSON FROM THE BIRDS.—"Be not anxious for your life, what ye shall eat; nor yet for your body, what ye shall put on. . . . Consider the ravens, that they sow not, neither reap; which have no store-chamber nor barn; and God feedeth them; of how much more value are ye than the birds! . . . Seek ye His kingdom . . . a treasure in the heavens that faileth not, where no thief draweth near, neither moth destroyeth."

Questions

1. Name some small animals with protective colouring.
2. Of what colours are weasels and stoats?
3. What different means of protection does a hare possess?
4. What is a rabbit's food?
5. How are young rabbits different from young hares?
6. How do hares and rabbits warn their young of danger?
7. How can you tell a "rodent"?
8. Describe a squirrel's nest, and the nest of a harvest mouse?
9. What is a water vole's food?
10. Name some insects with protective colours.
11. How are sunflies protected?
12. What difference of colour do we often notice between wild animals and their tame allies?

JANUARY 15

Steam in the Sky

CLOUD PICTURES.—We all look at the sky when we want to know what the weather is going to be like; but I wonder if you ever thought of the sky as a great picture-book? When I was a child my old nurse used to teach me to look for "pictures in the clouds," and what funny shapes we would see! Sometimes a big lion, sometimes an old man with a hooked nose, or a dog sitting upon its hind legs, and many other queer things. And if as you grow up some of you become artists, I think you will find clouds and skies well worth your attention. I advise you to begin at once to learn to watch the clouds, their curious shapes and beautiful colours. And this can be done all the year round. On fine winter days, though there are few birds or flowers about, there is always the sky to admire.

HOW CLOUDS ARE MADE.—Let us go out now and see how many different sorts of clouds we can count, and whether we can give names to them. We must think first how they are made. They are made of drops of vapour or moisture which are rising continually, chiefly from the ocean, but also out of every pond and puddle and river on the earth. You know if you leave even a glass of water for some time, the water will gradually disappear by what is called "evaporation," that is, the water passes off in vapour. Now when warm moist vapour rises into the colder parts of the atmosphere (that is, the air surrounding the earth), the vapour becomes "condensed," that is to say, it turns into clouds, so that you can see it. As we sometimes know the state of a man's mind by watching

his face, so we can tell the state of the atmosphere by watching the face of the sky.

HOME-MADE CLOUDS.—You can make a cloud yourself in a moment on this frosty day, by just breathing on a window pane; your warm breath "condenses" on the cold glass and makes a mist; and a cloud is just mist in the sky. Or, when you go home to tea, look at the kettle boiling, and you know you will see a cloud coming out of the spout; that is the warm moisture from the boiling water condensing in the colder air. You can see very distinct white clouds coming out of the chimney of a fast railway engine as it puffs and rattles past. Or hold a spoon over your cup of hot tea, and notice the warm moisture rising from the tea and clouding over the cold metal.

Strange to think that the steam from the tea-kettle, and that beautiful cloud in the sky yonder, are really first cousins!

CIRRUS CLOUDS.—But now I must introduce you to the clouds by their names. First, let us learn to know a "cirrus" cloud when we see it, which has been called a curl cloud. It is the very highest kind of cloud, and often we notice it in long streaky wisps, or feathers, or wheel-spokes, and then we call it "mares' tails." It is made up of ice dust or snow crystals.

CUMULUS AND STRATUS CLOUDS.—All clouds really belong to one of two families. The one family includes all the "cumulus" clouds, so called from the Latin word for "a heap," and the other family contains the "stratus" clouds, from the Latin word for "a bed." Some clouds are half cumulus and half stratus. Cumulus and stratus have also been named "stack" and "fall" clouds.

The cumulus is called "the cloud of the day." It really forms the top of the currents which rise into the higher colder regions, when the ground has been heated

by the sun. Warm air always rises. Then its moisture spreads, gets cooler, and condenses into cumulus cloud.

The soft, smooth "woolpack" clouds, which we see in fine weather are cumulus. Then there are cumulus clouds which bring rain. If they come without wind they are shower "cumulus." "Squall cumulus" comes with wind or hail or snow. The great clouds which

Cumulus Clouds.

collect before thunderstorms are halt cumulus and halt stratus, called "cumulo-stratus," and sometimes pass into the "nimbus" or rain cloud.

STRATUS CLOUDS.—Stratus clouds are of a long shape, spread out in sheets, instead of being in heaps and masses. The stratus is called "the cloud of the night." A quiet stratus sky means fine weather. A "mackerel sky" is formed of stratus clouds at a great height.

FOG.—I told you that a cloud is really a mist in the sky. And fog, in the same way, is a big stratus cloud enveloping everything. If you were to climb a very high mountain and get into the clouds which hang over its top you would simply find yourself in a fog.

A traveller has described to me how, above Zermatt, 7000 ft. above the sea, she saw a cloud descend into the valley below, and the moon shining out at the same moment caused reflections in the cloud as though it had been a kind of lake. Gazed at from among high mountains, the clouds beneath seemed like wanderers broken loose from their companions.

HALOS.—You may sometimes see a bright halo round the sun or moon. This is caused by light shining upon the fine ice crystals which make up very high cirrus or stratus clouds.

TRAVELLING CLOUDS.—Clouds sometimes move very fast. I know few more beautiful sights than a cloud rushing across the face of the moon. It looks, does it not, as if the moon herself were passing quickly along through the midst of the clouds while silvering their edges with her beautiful light?

CHANGES IN THE SKY.—If you watch the sky at different times of the day you will find out something more for yourself about the clouds. I think you will find that there are more clouds in the early morning, just before sunrise, than there are after the sun has risen. You will notice this particularly over the sea. In the early morning the clouds are generally either "cumulo-stratus," or else fog. After sunrise it is generally less cloudy, till about mid-day, when the sun has heated the earth and caused the warm currents to rise. In the warmer months especially, there seem to be most clouds in the afternoon. Cumulus clouds are common on hot afternoons, topping the warm, rising currents of air.

SEEN FROM A BALLOON.—Mr Bacon, the great balloonist, has described what he calls "the cloud floor," which he found beneath him when he was up in his balloon, about one o'clock in the afternoon. He says that at first it looked like lately fallen snow, lying deep, and yet light and feathery. Then it became like a snowfield, harder and closer, resembling even snow under a winter sun. And then it changed again and looked like a snow plain, breaking up slowly into black pits and hollows, through which he caught glimpses of the earth far away below.

COLOURS IN THE SKY.—Do you know what causes all those glorious colours in the clouds, which we often see, especially at sunrise and sunset?—"the clouds in thousand liveries dight," as Milton says. If you do not know, I think you would never guess. They are caused by grains of dust, and tiny particles of water vapour! If there were no dust and vapour in the atmosphere, the sky would be always of a dull grey. The dust and water particles break up the sunbeams which strike upon the clouds, and throw back the various colours of the beams. You may understand this better if you recall our lesson on light and colour.

STRENGTH PERFECTED IN WEAKNESS.—Who would have thought that little despised motes of dust could help to make those gorgeous colours of the sky in which poets and artists delight? But so it is; for the Creator, Who "maketh the clouds His chariot," never despised the day of small things, and can bring strength out of weakness and beauty out of the very dust of the earth: just as He can take our feeblest efforts and turn them into good, if we will only do our best, and leave the rest to Him.

Questions

1. Of what are clouds made?
2. Give the names of the two principal kinds of clouds, and the meaning of the names?
3. How could you make a cloud?
4. What is fog?
5. How are halos formed?
6. What sort of clouds are common on hot afternoons?
7. How do dust and water particles help to cause the colours of clouds?

FEBRUARY 1

White Crystals

THE BUILDING OF A SNOWFLAKE.—We have thought of clouds and learned something about rain. To-day shall we have a lesson about snow?

A snowflake is built up on the little atoms of dust which float about high up in the air. It is supposed that the tiny drops of water which make the clouds are "condensed" on dust in the same way. A snowflake is formed if the vapour in the clouds is at a very low temperature. If it is first formed very far above the earth, it adds to the store of frozen vapour in the clouds. Then, when it comes down on the earth, it will be as snow.

HOW IT BECOMES LARGER.—If the snowflake, on its way down to the earth, has to pass through different portions of air, some warmer, some colder, it often gets larger. It gathers up moisture in a warm

part of the air, and then passes into a colder part, where the water vapour is quickly frozen again, and so it goes on getting larger and larger till it falls to earth. A snowflake entraps vapour very easily, for it is full of little sharp needles and jutting-out points, which catch the floating drops. You know if you take a snowball into your warm hand and hold it for a little time, some of the snow becomes melted, then the water gets frozen again, and you can weld and squeeze it into a hard lump.

SNOW CRYSTALS.—A snowflake is made up of little ice crystals joined together, with air between. If

Snow Crystals.

you looked at snow through a microscope you would see the ice crystals, in beautiful shapes and patterns, rather like the pretty shapes in a kaleidoscope, and with three or six sides to them. Some have a lozenge or tablet shape, some are like stars with rays, others like flowers with six petals, some like pyramids, others have little hollows filled with water, or air, or both, and so on. There are said to be a thousand different kinds of snow crystals, but the crystals of any one snowstorm are generally much alike in shape.

A drop of sea water also looked at through a microscope as it evaporates, shows salt crystals breaking up and forming themselves into little squares and prisms.

WHITENESS OF SNOW.—You know the wonderful whiteness of snow which has just fallen; even the white

feathers of a swan, or clean cotton wool, look soiled and dirty near it. This is because the tiny crystals are like so many little mirrors, breaking up the seven colours of the sunbeams, and the whole mass of snow blends and joins together these prismatic colours and throws back the dazzling white light. This is why snow and hoar frost glitter and sparkle in sunshine.

USES OF SNOW.—Can you think of any uses of snow? Well, for one thing, it helps to water the ground. About ten inches of snow answer to one inch of rain. But perhaps its chief use is to be like a sort of fur cloak to cover the ground and keep the seeds warm beneath it. When there is snow, the ground is kept at the same temperature day and night. But when a thaw comes and snow water trickles through the land it makes it much colder.

Clean pure snow throws back heat, but when once dirt and dust have settled upon it the snow begins to take in heat and absorb it. The winds become cold when they blow over large tracts of snow.

SNOW MOUNTAINS.—You learn from your geography books that in many parts of the world there are high mountains the tops of which are always white with snow. There is a boundary called the snow line, above which snow is always present. Of course the snow line is much lower in some parts of the world than in others. It depends on the usual temperature of the country, and on whether the winds blowing over it are mostly dry winds or wet ones., On some South American mountains, near the Equator, the snow line is always above 15,800 ft.; but in Iceland the mountains are covered with everlasting snow above a height of only 3100 ft.

HOAR FROST.—What is hoar frost? It is just frozen dew or mist. If you go out early on a summer morning you often find the ground covered with dew.

How did it come there? In old days people used to think that dew fell from the sky, but you can easily see this is not so, for you find dew under leaves—underneath things, and also on their sides—where it could not be found if it had fallen from above. No, the ground, and the stalks and leaves of plants, etc., gave off their heat during the night, and so became colder than the air which touched them ; the air was full of vapour, and the

A Frosty Day.

vapour "condensed" on them into drops of dew. Just as if you take a glass of cold water into a hot room, the vapour in the room condenses on the outside of the cold glass and trickles down it in drops. And when the temperature of the air is below freezing point, or the leaves of trees, ground, etc., are very cold, on a winter's day, the vapour is condensed on them into hoar frost or frozen dew. Hoar frost has six-sided ice crystals like those of snow. You find this dew ice in the shape of tiny icicles, and also as globular drops.

HAILSTORMS.—Hailstorms are brought about when hot and cold winds rush together, and the air being disturbed and rent by the winds, and sometimes by lightning, its vapour is frozen into hail. Both snow and hail are very electric.

WHITER THAN SNOW.—White snow may be taken as a picture or symbol of holiness and purity. In the Psalms we find a beautiful prayer, "Wash me, and I shall be whiter than snow" (Ps. li., 7); and to that prayer, if made in earnest, is God's answer, "Though your sins be as scarlet they shall be as white as snow." (Is. i., 18).

Questions

1. How is a snowflake first formed?
2. How does it get larger?
3. Of what is it made up?
4. What are snow crystals like?
5. Why does snow glitter in sunshine?
6. What are the uses of snow?
7. What does the snow line on mountains mean?
8. What is hoar-frost?
9. How are hailstorms brought about?

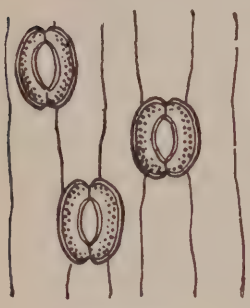
FEBRUARY 15

An Underground Treasure-house

THE FOOD OF PLANTS.—We were speaking a few months ago of plants feeding on some of the minerals which they get out of the soil. You know that plants drink in water out of the soil through their roots, and melted down or dissolved in the water, like

sugar in tea, they take in various things, such as nitrogen, phosphorus, sulphur, lime, which help to build them up and keep them alive.

CARBON DIOXIDE.—But plants do not only drink in by their roots. They also eat by their leaves. Every leaf of every tree, shrub or plant of any sort is full of little mouths (called stomates) which suck in food from the air; and to this food is given a long name, "carbon dioxide." What happens to the carbon dioxide when it gets into the leaves? It begins to break up; by the help of sunlight it gives up all its *carbon* to feed the plant, and the rest of it, the gas called *oxygen*, flies away and escapes back into the air, and there it helps to keep animals alive; for you and I and all other animals must breathe in oxygen to live.



STOMATA.

STARCH.—Well, that is how plants get their breakfast and dinner and supper; and they are eating and drinking all day long! But now I must tell you something of what happens to the carbon, and the liquid food from the roots, when they join together inside the plant cells. They go to form starch for building up and feeding the plant.

CELLS AND VESSELS.—If you took a very thin slice of any part of any plant, and looked at it under a microscope, you would find it made up of cells, forming a sort of honeycomb. The inner part of the trunk of a tree is full of woody tissue; its cells would be longer than broad, and have thick sides or walls. It also has a number of long canals or tubes, called vessels, of different shapes and kinds, some twisted, some marked with slits or dots or pits or rings. These cells and

vessels hold and carry the sap, sugar, starch, chlorophyll, etc., which feed the plants and keep them alive.

THE POTATO PLANT.—This brings us to a very common eatable which I daresay you often have for dinner, and which is full of starch—a potato. That is how the potato is fed which in turn feeds you. The potato plant which you see in the garden, with its dark green leaves and handsome white or lavender-coloured flowers, draws in food by its roots and leaves, and that food turns into starch. But it is a very careful plant; it hoards up supplies of food, and the potato which we eat is really the potato plant's storehouse which it was filling up with starch for a future day.

TUBERS.—For the part we eat is what is called a "tuber," that is, an underground stem, filled with the starch which nourishes the plant. And you know the little "eyes" on the potato? These are tiny buds which grow into new plants if it is left alone and not eaten. You can see the same sort of tiny buds at the side of a hyacinth or crocus bulb. The crocus "corm" or bulb is full of starch, and is roasted and eaten in Syria.

There are other plants, such as English orchids, which lay up supplies of food in tubers. If, again, we dig up this lesser celandine (pillwort), we shall find that it throws out tiny tubers, looking like toy potatoes, with little eyes or buds. Many plants lay up stores in their roots.

CULTIVATION OF POTATO.—I daresay you know that Sir Walter Raleigh first brought potatoes into Great Britain, from Virginia in America, in 1586. He planted potatoes, and tobacco also, in his garden in Ireland. But for about one hundred years they were only grown in a few private gardens. They were first planted out in open fields in Lancashire. In the house-

hold accounts of Anne, Queen of James I., potatoes are entered as costing one shilling the pound.

POTATO STARCH.—Potato starch is used in various ways, and amongst other things for calico printing, and for "British gum," so useful for envelopes and the backs of postage stamps.

BITTER-SWEET, Etc.—Oddly enough, this wholesome vegetable has for relations the dangerous bitter-sweet, with a flower very like that of the potato, and bright red berries in the autumn which I hope you know and are careful to avoid; the more uncommon deadly nightshade or belladonna, with its poisonous purple black berries; and the henbane, which though valuable in medicine is very dangerous if used without knowledge, and gets its name from being poisonous to fowls.

LIME.—Speaking of the food of plants, it is curious to notice that some food agrees well with plants and other kinds disagree, just as with human beings. Lime helps some plants to digest their food. I will tell you how. Too much of one particular substance called silicon is bad for plants, just as too much cake is bad for children! and when there is lime in the soil, it helps to form a substance which prevents the silicon from dissolving, so that it cannot get into the plants in any quantity to hurt them. Farmers will tell you that lime "sweetens the soil."

ROTATION OF CROPS.—Some soils, that is to say, some particular substances in the soil, suit certain plants better than others. So you have heard of the "rotation of crops." What does it mean? Farmers find that after one crop has been in a field for any length of time, and has taken up certain foods out of the soil, it is better to follow it up with a different kind of crop, which needs a different sort of food. Then too, after a good many crops have followed each other in the field, the

soil needs "manuring," that is to say, the farmer must put nitrates and phosphates in the ground, and give the plants a fresh supply of food.

And wild plants have a way of their own of "rotating crops." Thus many plants have winged or feathery seeds which are blown to a distance and start growing in a fresh soil. Or they travel along like the blackberry brambles, which send out long, hooked, climbing stems, arching over and rooting themselves in the earth in some fresh place, and thus making new plants at a distance from the parent stem. Some again, like our friend the celandine, send out tubers, causing them to change their place from year to year.

DECAY AND PRESERVATION OF ROCKS.—We remember[1] that the soil and earth on which plants feed are made from the rocks and stones which have crumbled away. Plants often help to make rocks crumble away; can you guess how? Partly by keeping them moist while they are growing upon them, and attracting the rain, and holding the dew; and this wet and moisture of course hasten the decay of the rock. Then too, when the plants begin to die, they give out carbon dioxide which helps to corrode the rock. And their roots sometimes loosen the stones and rocks when they creep down into their crevices.

But we must also give the plants the credit due to them, and remember that sometimes they also help to preserve rocks and earth; when, for instance, a rock like this one here is covered with a nice thick table-cover of turf and moss; or when brushwood protects soil on these slopes from being washed away; or when the roots of plants serve to bind loose soil together.

FELLOW-WORKERS.—When we notice how rocks and plants and atmosphere and animals all work together to help and serve each other, let us give glory to

[1] *See* page 123.

the Almighty Maker and Preserver, Who brings great things out of small and life out of death.

Questions

1. What do plants take out of the ground through their roots?
2. What through their leaves?
3. When the carbon dioxide breaks up the cells of the leaves, what happens to the oxygen?
4. And what to the carbon?
5. What part of the potato plant is the potato which we eat?
6. What is it filled with?
7. What are the potato's "eyes"?
8. Name some other English plants with tubers.
9. What poisonous relations has the potato?
10. How is lime good for some plants?
11. What is the meaning of "rotation of crops"?
12. How may plants cause rocks to decay?
13. How may they help to preserve rocks?

MARCH 1

Light and Colour

VARIETY OF COLOURS.—It would be interesting to count up how many different colours we can see around us in Nature in the course of a walk. On this March day we may not find so many as we should in summer, or when the tints of autumn are all about us. But even to-day we may notice a good many. Look

at the sky with its variously coloured clouds; and there is the green of the grass, the brown of the dead oak leaves, the bright red of this toadstool, the pretty plumage of those wild duck. It would be a dull earth indeed if everything were of one colour! What is the cause of so many different beautiful colours?

PRISMATIC COLOURS.—Well, colour comes from our friend the sun. If you take this bit of three-cornered glass, called a prism, and hold it over a piece of paper and let a sunbeam pass through it, you will see all the colours of the rainbow thrown on to the paper. Those colours are, red, orange, yellow, green, blue, indigo, violet. The prism has cut up and separated the seven rays of the sunbeam.

A rainbow is caused in the same kind of way. The sun shines on the drops of rain in the sky, and each drop is a little prism cutting up and dividing the rays of the sunbeams. You may see the same colours sometimes when the sun bursts through a fog; the drops of moisture break up his beams, and the colours may be noticed on the moist window pane. Or if you place a pail of water in the bright sunlight, and give it a good shake so that the water splashes up in the sunrays, and the drops catch the light and break it up. Sometimes too we see a "corona" or crown of rainbow colours round the moon, especially if rain is soon going to fall. You know that the moon gets her light from the sun; moonlight is just reflected sunlight; and the thin drops of mist vapour between us and the moon will break up her light into the seven colours.

CAUSE OF COLOUR.—Here is a snowdrop. How is it white? The flower gives back—"reflects"—all the seven rays of sunlight, and absorbs or swallows up none. But see, its stalk is green, how is that? The green stalk reflects, or gives back, the green rays, and swallows—absorbs—the rest. Overhead I see a black rook flying. We must not speak of his "black colour,"

for black is not a colour; it is just absence or want of colour; a thing is black when it absorbs or swallows up all the seven rays of sunlight and gives out none. And so if you were to come out here on a dark night, the grass, for instance, would be really black, for there would be no light for it to reflect.

ETHER.—Light is a very mysterious and wonderful thing. The voice from the whirlwind asked of Job

A Rookery.

"Where is the way to the dwelling of light?" and it is a question to make one think. Wise men tell us that light is brought to us through that strange thing which nobody can see, feel, touch, or weigh, called ether. This ether fills all space; it moves itself in waves, and the waves carry light to us from the distant sun and stars.

Come with me to this pond, and let us throw a stone into it. You see what happens; the stone tumbling

into the pond makes a ring in the water, and the ring widens and spreads, and its waves seem to move towards us; but the waves are not really moving towards us. Throw a cork into their midst, and you notice that it is not carried towards the shore; it just rocks up and down, to and fro, on the water. The waves simply tremble and dance up and down, and each dancing wave of water starts another wave.

Now this is just what is supposed to happen in the ether. The sun set the waves of light trembling and dancing to and fro, as our stone set going the waves of water; and so they swing along till they reach our eyes, unless there is something in the way to catch and turn them.

HOW WE SEE.—But of course everything which we see around us catches and disperses the light rays, and that is how our eyes see things when we look at them.

Over there, for instance, is a robin sitting on a gate. How do we see it? The light rays strike on the robin's head, on its wings, on its tiny claws, on its little tail, and all these different objects catch the rays and send them bounding along in wave circles to your eyes, and the nerves of your eyes telegraph, so to speak, a message to your brains: one ray says, "I come from a robin's head"; another, "a robin's wing"; another, "a robin's claws"; another, "a robin's tail," and all these messages put together flash to your brain, "I *see* a robin."

SPEED OF LIGHT.—How long do you suppose it takes those sunrays to reach our earth? They have to travel through a distance of about ninety-two or ninety-three million miles. A cannon ball would need more than seventeen *years* to make that journey. But light speeds along it in a little over eight minutes.

ETHER WAVES.—Another curious thing to think about is the number of vibrations made by the ether

waves. The different colours depend upon the tremblings of the waves. To give us the sensation of red in our robin's breast, the waves vibrate about 395 millions of millions in a second. It may well take your breath away to think of it. But as I passed through my garden just now I saw a violet crocus. To give me the sense of violet colour, the waves were quivering at the rate of 763 millions of millions in a second!

OPTICS.—The whole subject of light is intensely interesting, and needs much study to understand it. The manufacture of lighthouses, telescopes, microscopes, spectacles, magic lanterns, and many other glass instruments, and the whole of the photographer's work, depend upon the right understanding of the science of light; and its students are constantly making new discoveries.

HEAT AND ELECTRICITY.—One interesting fact is that the waves of light and of heat, and some say, of electricity, are now believed to be the same, and to be all carried through the ether, though they differ in length. We feel the long waves of heat and we see the shorter waves of light.

THE LIGHT OF LIFE.—Light, so pure, so beautiful, so mysterious and wonderful, is often taken in the Bible as the picture or symbol of holiness, and even of God himself. "God is light," says St John, "and in Him is no darkness at all."

Questions

1. What is a prism?
2. Name the seven colours in a sunbeam.
3. How is a rainbow caused?
4. How is a snowdrop white?
5. How is a holly leaf green?

6. How is a crow black?
7. What carries the light to our eyes?
8. What happens to the light rays when they fall on an object?
9. How long does a light ray take to reach the earth from the sun?
10. Which colour is caused by the greatest number of vibrations—red or violet?
11. Which waves are the longer—those of heat or those of light?

MARCH 15

The Plant on the Wall

MOSSES.—People talk sometimes as if there were nothing interesting to see out of doors in winter and early spring; but we will try if this morning we can find some pretty little plants well worth our study. There are plenty along the side of this path in the wood, and of many different kinds—I mean the mosses.

THE SPORES.—Mosses have no flowers. The part which draws our notice at once, in many mosses, is this little cup on a stalk, which holds the seed, the books call it an urn. In many of the mosses the urn has at first a little lid, which falls off when the seeds are ripe, and then you can see, inside the cup, the seeds or spores as they are called. Often the rim of the urn has rows of tiny teeth.

You see plenty of urns with lids in the common feather mosses,[1] and in these screw mosses.[2] Pick a

[1] Hypnum. [2] Tortula.

tuft of this wall screw moss and put the green part in water, and you will see the tips of the urns gradually open out and the little yellow teeth show themselves; and if you look at them through a pocket lens you will see they are like little twisted screws or coils of hair, which will slowly untwist themselves.

HAIR MOSSES.—In damp places under the trees we shall probably find some wavy hair mosses.[1] Some may have the urns of spores shooting up out of the stems on long thin stalks; there is a little covering to the urns made of silky hairs, which give the mosses their name, and the urns also have queer long beaks. One kind of hair moss has sixty-four little teeth. But here are other stems which end in little stiff rosettes of leaves; these leaves hold the tiny antherids, which answer to the stamens and anthers in a flower. They are full of wee things something like the pollen grains of flowers, which are always moving and twirling round and round, and they make the mosses fruitful and cause the new plants to grow.

Common Hair Moss.

Gilbert White tells us that the dwellers in Wolmer Forest made "neat little besoms" from the stalks of hair moss, for dusting bed curtains, carpets, etc.

GEMS.—There are some mosses which bear new plants in another way, not only by spores, but also by growing little cells, which the books call "gems," on the ends of the leaves, looking rather like eggs. This lovely little pellucid four-tooth moss,[2] here in this damp hollow, has egg-like gems on its leaves.

BOG MOSSES.—If we go to a bog we may come across some very interesting members of the turf or bog moss family. The bog mosses have no proper

[1] Atrichum undulatum. [2] Tetraphis pellucida.

roots. They just suck in water through little threads on their stems. They are often very useful, for they fill up the water in pools and bogs. As the plant grows, and sends out new side shoots, the under part decays, and this decayed part heaps itself up in the pool or marshy ground, other plants get entwined with it, and thus earth is slowly formed, so that in time the black useless swamp may become good green pasture land for cattle "redeemed" by the bog moss.

But parts of old trees, which are often found kept by the peat, seem to show that in many places there were once great forests where now there are only turf bogs, and the bog mosses seem also to have had a large share in choking up, and helping to drown or rot the ancient forest trees, by collecting moisture.

The turf or bog mosses are like little sponges in the way they collect water. Their leaves are often shaped like boats, and turned over at the edges to hold water; and both leaves and stems are full of large cells with openings to let the water in. If you take a dry bit of bog moss and put it in water, you will see how quickly it sucks up the moisture.

PEAT.—The great peat bogs and moors of Scotland, Ireland, and some parts of England, are formed of bog moss, though the peat in the fens of Lincolnshire seems to be largely made up of feather moss.

MOSS ROOTS.—Linnæus called mosses "servi," or workmen, because they seem to work at making soil where it was not found before! In those mosses which have roots, the roots are very thin, easily bent, and covered with a sort of sticky gum, so that they can squeeze into the tiniest slits in rocks, or fix themselves in shifting sands.

CLUB MOSS.—The club mosses are not properly speaking mosses. Like the horsetails, they are relations of the fern family. The seeds of the common

club moss,[1] or stag's horns, catch fire easily, so they are much used in fireworks.

HORSETAILS.—These club mosses and horsetails are specially interesting because they come from ancestors which were giants! Learned men who study fossils tell us that in the great forests of the Coal Age, where the plants grew which became pressed down into peat bogs and turned into coal, there were gigantic plants related to club mosses and horsetails, 50 to 70 feet high.

MAIDENHAIR—SPLEENWORT FERN.

FERNS.—As we wander through the wood we may come across some baby ferns, rolled up like periwinkle shells. Here is a young common male-fern, and here we see some of last year's dead ferns, brown and withered.

FRONDS.—You know that they have long leaves, which in ferns are called "fronds," toothed all along the edges like a saw; almost all ferns have their leaves cut up into little leaflets in this way. The reason seems to be that as ferns generally grow in shady, overgrown places, they are cut up so as to catch every atom of carbon out of the air, and

[1] Lycopodium clavatum.

entrap every chance ray of sunlight, as much as they possibly can.

THEIR SPORES.—When our baby fern untucks itself and slowly rolls out its leaves, what shall we find on the backs of the full-grown fronds? A number of little hard things, which in the male-fern are shaped like kidneys, and after a time they will burst and pour out quantities of tiny egg-like balls, the spores. As these spores ripen, little cells will grow within them, which you could only see with a microscope; they answer to the stamens, pistils and ovaries in flowers; after a time these cells die away, leaving a frond bud, and from the bud springs the new baby fern.

Unfolding Leaves of Hart's-Tongue Fern.

TREE FERNS.—Our British ferns, as you know, die down every autumn and come up again in spring, and their fronds are seldom longer than 3 or 4 feet: but in the forests of Brazil and other hot countries, the ferns grow to a great height, and become actual trees, 40, 50 or even 80 feet high.

THE STEMS.—Many ferns have hairs or scales on their stems and rootstocks. Often the roothairs grow very thick, probably in order to collect as much moisture as possible; for ferns, as you may have noticed, love moisture. The stems of this common bracken often creep far underground.

BRACKEN.—Bracken by the way is a very useful fern. When it is burnt it makes a very good manure, especially for potatoes, as it is full of nitrogen. And it is used very much in packing fruit, potatoes, and fish, and also as litter for cattle, etc.

FERNS MENTIONED IN OLD BOOKS. — Old writers used to recommend various ferns as medicines

and for healing wounds. And they often come into fairy tales, where the fairies are said to use the fronds as saddles; and if a man caught fern seed into pewter plates on St John's Eve he became invisible!

SCALE FERNS.—Most ferns like wild ground, but a few, such as this scale fern, like best to grow on rocks and walls, and seem to become more abundant as time goes on and more walls and houses are built.

THE HYSSOP ON THE WALL.—The wise King Solomon did not think it beneath him to look into the little things of Nature as well as the great; and "he spake of trees, from the cedar that is in Lebanon, even unto the hyssop that springeth out of the wall."[1] This hyssop is thought to be the little beardless moss,[2] which grows in scattered tufts on the walls of Jerusalem. It is part of the wisdom of man to study what the wisdom of God has created.

Questions

1. What part of a moss is the urn?
2. Whence has the screw moss its name?
3. Why have the hair mosses this name?
4. How does the pellucid four-tooth moss bear new plants?
5. How do the bog mosses take in water?
6. What mosses form peat?
7. Why are club mosses and horsetails specially interesting?
8. What are fern leaves called?
9. Where are ferns' spores to be found?
10. What are the uses of bracken?

[1] 1 Kings iv. 33. [2] Gymnostomum truncatum.

APRIL 1

Johnny Appleseed

CRAB APPLES.—We are going to look to-day for a tree with pretty white blossom, but the fruit of which we do not care much about: I mean, a crab apple tree. Its flowers are beautiful, with a rosy tint on the underside of the petals, but its fruit when it appears in autumn is less pleasing—little apples with a sharp bitter taste. However, it has some very nice relations. You can tell me their names? The good apples—the pippins and codlins which we enjoy so much—are its grandsons; so are the pears, which are borne by very handsome trees, taller sometimes than the apple trees.

THE ROSE FAMILY.—And here are some more of its relations. This beam with its young shoots and leaves covered underneath with soft, white cotton, and which will have red berries in autumn; this wild service tree, also with down on its leaves, disappearing as summer advances; and this pretty rowan tree or mountain ash, which in autumn will have beautiful little bright red berries. These all belong to the great rose family, and so does that queer quince tree with its fruit looking half like apples half like pears, which you may have seen in the squire's garden.

Mountain Ash.

THE FRUIT.—If you cut an apple open you know what you find—a hard "core," and in it a few little pips or seeds, each in a neat cell. Do you know what part of the plant this core is? We can find the answer by pulling the flower to pieces. If you take off the five white and pink petals, the numerous yellow stamens, and the pistil, you find there is left the green calyx or "flower cup," with a hard lump in the middle, called the ovary, holding the seeds. Now when the rest of the flower dies in the autumn, this "calyx tube," as it is called, and lumpy ovary, stay on and grow up into the apple. The "core" is the real fruit, for it is the core which holds the seeds or pips. Sometimes you may see one or more of the five calyx leaves, dead and withered, still clinging to the top of the apple.

THORNS.—The plums also belong to the great rose family, and we know how the wild plum or blackthorn has thorny branches. Have you not often seen wild apple or pear trees with thorns on their branches too?

And another near and thorny relation of the apples and pears is this hawthorn, may or whitethorn. Its seeds are in bony cases, instead of in little cells, inside the pretty red haws. Its thorns are simply very tiny branches which never grow larger (while the spikes of that gorse which we saw just now by the roadside are hardened leaves); and no doubt they are very useful to the hawthorns, to protect them from being eaten by cattle, as a hedgehog is protected by its spines.

COTONEASTER.—I must just tell you about one other very solitary near relation; it is called cotoneaster, and only grows in one place in Great Britain, on limestone cliffs at Great Orme's Head. It is a little shrub with pink flowers and red berries; and its leaves are covered underneath with soft down like those of the beam and wild service. Is it not a pity that collectors have been so thoughtless, and nearly

done away with cotoneaster altogether by rooting up plants wherever they found them?

APPLE ORCHARDS.—There are great apple orchards in Herefordshire, Gloucestershire, Worcestershire and Devonshire, where apples are grown for cider. The best cider is made from a mixture of bitter and sweet apples.

APPLE LEAVES AND APPLES.—We were thinking lately of the little mouths or cells—"stomates" as they are called—in the leaves of plants, with which they take in carbon dioxide from the air. More than 100,000 of these little mouths have been counted in one leaf of an apple tree. The leaves are eaten by horses, cows, sheep and goats. A yellow dye is made from the bark.

You may have heard of Glastonbury, with its splendid Abbey; it used to be called the Apple Orchard, from the great quantity of apples grown there before the Romans conquered Britain. The old Welsh bards were honoured for their music by being given an apple spray.

Pomatum is said to have got its name from being first made of the pulp of apples beaten up with lard and rose water: "pomus" is Latin for apple.

Apple trees seem to thrive best on limestone. They grow all over Europe.

JOHNNY APPLESEED.—The United States of America honour the memory of a youth named Jonathan Chapman, best known as Johnny Appleseed. When he was only twenty-six, in the year 1806, he took a load of apple pips across the River Ohio, to sow on the western frontier, travelling in two canoes lashed together. He also made many long, hard journeys on foot, sometimes as much as 150 miles, carrying apple seeds in leather bags, slung across his shoulder or on the back of a horse. Thus he trudged along,

planting his seeds everywhere, always bare-foot, and dressed in a queer garment made of a coffee sack with holes cut for his head and arms, and a hat of pasteboard with a great peak in front to shade him from the sun. One hard snowy winter a settler forced a pair of shoes upon him, but a few days later met him again plodding along cold and bare-foot as ever, and learnt that Johnny had given the shoes to a poor man who he thought needed them more. Even during the war of 1812 he did not give up his wanderings, and was never hurt by the Indians. He carried on his useful task, hard-working and unpaid, for forty-six years, and died at the age of seventy-two.

GRAFTING.—You would find it interesting to watch a gardener grafting apple trees. He may take a young branch out of one kind of garden apple tree and graft it into the stem or "stock" of another, or he may graft a branch of a garden tree into the stock of a wild crab apple tree, and thus make a good tree of nice garden or kitchen apples.

GOOD FRUIT.—Fruit trees may teach us a little parable. By nature we are like wild fruit trees, bearing no good fruit, but if we will "abide in Christ," who is "the true Vine," we shall "bear much fruit," and so be His disciples.

"Saviour, may we ever be
Grafted, rooted, built in Thee."

Questions

1. To what family does the apple tree belong?
2. Name some other trees of the same family.
3. From what part of the plant is the apple formed?
4. What are the thorns of the hawthorn?
5. Where would you see great apple orchards?
6. What animals eat apple leaves?
7. What good work did Jonathan Chapman do?
8. What is grafting?

APRIL 15

Swimmer and Jumper

FROG-SPAWN.—I think there are few more interesting things to watch in Natural History than the life history of a frog or toad, beginning with its egg, and

Eggs of Toad.

going on through all its tadpole stages, till it becomes a full-grown animal living partly on land, partly in the water. To-day we will go and hunt for frog spawn, and we might bring some back to school and keep it in a glass globe of water to see if it will hatch.

Down in this standing pool I see some jelly-like spawn. Toads' spawn is laid in strings, not in lumps

TADPOLES

and masses like this of a frog. You see each little black egg is surrounded by the transparent jelly, which is like a cushion, keeping the separate eggs from knocking one against another.

TADPOLES.—Now if we search in the water we may find baby tadpoles—ah, here are some! We might keep them also in a large bowl and watch them grow, for they will be quite happy and comfortable there so long as they have plenty of pond water. You see they are like little fish; and they breathe through gills as fish do. Their mouths are rather like beaks, and they feed on soft vegetable stuff. Can you find any a little more grown? Yes, here are some which must be six or seven weeks old. Look closely and you will find signs of the legs coming, the hind legs first. And here are a few older still—eight or nine weeks; they rise to the surface to breathe, their lungs are beginning to form, and their gills to die away. In another fortnight or so, what will have happened to their gills and their tails? They will have disappeared and dwindled away. (The tails do not drop off, as some children think! but are absorbed to nourish the young frogs and make better heads.) The tadpoles will shed their skin, their legs will appear, their jaws will show, they will begin to feed on flies and worms, and they will leave the water, no longer tadpoles but frogs.

A curious thing will have happened also to their hearts. The tadpole has a heart with two "chambers," or divisions, which is the sort of heart a fish possesses; but the frog gets a heart with three "chambers," like that of most reptiles.

THE CHANGE.—It is very interesting to see a tadpole which is just about to become a frog. Its gills are dwindling down and its tail shrinking, the skin is spotted, the teeth indeed have not yet grown in the flat wide mouth, but it has the crouching way of sitting which you see in the full-grown frog.

A FROG'S HUMP.—Now let us examine froggy in his grown-up stage. One thing you may notice at once is the curious shape of his back which goes up in a sort of hump in the middle and then suddenly drops again. This is because the front part of the backbone is cut up into eight joints, and then in the back part it is joined together in one single piece.

HEAD.—Now look at its head; it is flat, and the mouth is very wide, with teeth in the upper jaw. The eyes are large, bright, and have three lids. It is very amusing to watch froggy feeding. His tongue is fastened to the front of the mouth, with the tip pointing down the throat. When he sees a fly sitting near him he shoots out his forked tongue like a flash of lightning, catches it on the tip and whips it down his throat.

LEGS.—Of course it is easy to see that the frog has very long legs because he wants to take such long leaps with them, and the muscles of his hind legs are also very strong. And you know he wants to move in another way besides jumping? He often wants to swim, and so his five toes are webbed like a duck's. I have read of a man who learnt to swim by watching a frog in the water, though of course the frog uses his legs alone, while we use arms as much as legs in swimming.

SKIN.—But if you keep a frog for a bit to study its ways, be sure you give it a chance of sitting on dry ground, and do not keep it altogether in water, for it only likes to go into the water occasionally. Froggy never drinks, but he takes in water through his skin like a sponge, and if left long without it he shrivels up and dies. If you find a frog which looks thin and dry but is still alive, and put it on wet blotting paper, you will see it gradually become plump and well again, as it absorbs the moisture. I have kept common frogs which became quite tame, and would crawl up my arm on to my shoulder.

COLOUR.—A frog often changes colour, and can be greenish, yellow or brown. It has a very odd way of getting rid of its old coat; it draws it off, as you might pull off a glove, rolls it and pats it into a nice ball, and then swallows it!

ENEMIES.—Frogs have many enemies. Serpents, vultures, storks and owls all prey upon them. In France and other countries they are often cooked and eaten, their hind legs especially being considered good eating, tasting rather like fried fish.

CROAKING.—If you watch a frog which is just going to croak you will see its throat swell, and then it puffs out its great cheek pouches with air. Abroad, frogs are nicknamed "Dutch nightingales," and in some parts of England "Cambridgeshire nightingales." The great bull frog of America is so named because its loud croaking is rather like the roaring of a bull. The horned-frogs of Brazil make a sort of barking noise, and can also bite like a dog.

TREE-FROGS.—In many parts of the world there are tree-frogs and tree-toads which live in trees. Many of the tree-frogs are brilliantly green, but some which are brown feed at night and lie quietly hidden during the day. The green ones of Europe are not afraid of creeping about among the green leaves during the daytime, as their colour matches the leaves and makes it difficult to see them. They have a very loud croak, which the French call singing. The West Indian tree-frogs have tadpoles with very small tails through which they breathe, and these tadpoles have no gills. In the South of France I have seen a few little frogs which were light blue, but they were rare. There are about 150 kinds of true frogs in the world.

TOADS.—Just now in a garden I saw a toad, and the gardener must have been glad of its company, for it

destroys insects. How did I know it from a frog? One difference is that a frog's tongue is notched which a toad's is not, and a toad has no teeth; but there are other differences plainer to see. A toad is more puffy, its skin is covered with warts, and it crawls rather than jumps.

Shakespeare has noticed toads, and referring to the old fable that there was a precious stone in their heads,

A Toad.

draws the lesson that good may come out of evil; for in those old days toads were wrongly supposed to be poisonous. Their skin, it is true, is poisonous, but they cannot spit poison.

> "Sweet are the uses of adversity,
> Which like the toad, ugly and venomous,
> Wears yet a precious jewel in his head.
> And this our life, exempt from public haunt,
> Finds tongues in trees, books in the running brooks,
> Sermons in stones, and good in everything."

Questions

1. What is toad-spawn like?
2. What is frog-spawn like?
3. How do tadpoles breathe?
4. What changes happen when they are about to turn into frogs?
5. What causes the hump in the frog's back?
6. How does it feed?
7. How are its legs and feet arranged for jumping and swimming?
8. How does it take in water?
9. What is its colour?
10. What are the tree-frog's habits?
11. What are the differences between frogs and toads?

MAY 1

A Living Oar

THE SHAPE OF A FISH.—We will go down to the river to-day and watch the minnows swimming about in the shallow part near the bank. You might be able to catch one in a net and keep it for a little time in a pail of water, and learn something about it. Have you ever studied the shape of a fish? You may notice, for one thing, that the minnow is made in the way which best fits it for cutting the water; its body is wedge shaped. Its limbs are fins. Those on its chest, acting together with its tail, steer the fish. And if it wishes to swim quickly forwards, it bends its tail, and the fins which are nearest the tail, very rapidly from

side to side. If it only wants to glide along leisurely, those fins and tail are simply waved gently backwards and forwards. The lobes or fringes of rays on the fins act like the blades of an oar.

A Sea Bream.

Supposing it had lost its fins it would turn over on its back, for those which it has in pairs, one on each side, which answer to a man's arms or legs, help it to keep its balance.

FLAT FISH.—The turbot, sole, and other queer-looking flat fish which you may see in a fishmonger's shop, swim quaintly on one side, always turning the same side towards the bottom of the sea; and oddly enough, the two eyes come to be placed together on the other side, towards the light. A flounder sometimes has its eyes on the right side and sometimes on the left. During the first week of their lives the young flat fish swim upright, and have their eyes in the usual place. Then one eye begins to travel across to come near the other, and instances have even been found of some accident stopping the migrating eye on its strange journey and it has come to a full stop just on the nose!

A FISH'S EYES.—Speaking of a fish's eyes, I am sure if you look at our minnow you will notice how very large and round the eyes are, giving the fish an expression as if it were continually staring! They are also very flat; and there are no eyelids, so that the eyes cannot shut. There is one kind of fish which is

called the star-gazer because its eyes are on the top of its head.

Some fish, which have been drawn up from very great depths, are blind; but others are found to have enormous shining organs, like great lanterns, to light them on their way through the darkness of the deep, and to help them to hunt down their prey—the smaller fish on which they feed. One brought up from the deep seas near the Azores had 64 shining glittering little bodies in its glassy organs, each like a lamp burning behind a glass.

It is no use looking for ears in our minnow, for fishes have no outside ears: their hearing organs are inside.

FISH-BONES.—You know something about its skeleton if you have ever eaten a fish for supper! You remember how carefully you looked out for its many bones. Fishes have long backbones made up of a number of smaller bones. A perch has forty-two joints in its backbone. If you ever see the skeleton of a shark or other very large fish in a museum, or if you ever come across the picture of one, notice also the curious arches of cartilage which support the gills.

GILLS.—A fish needs air just as you or I need it, but it breathes in a different manner. It takes in water through its mouth, breathes the air contained in the water, and sends the water out again through its gill openings, for it does not want to swallow it. The gills are generally like rows of scales or plates, long, flat and pointed.

FINS.—You may have seen pictures of the flying fish which use their fins as parachutes to help them in their great jumps over the waves. The gobies and lumpsuckers use the fins as suckers with which to fix themselves to stones. Gobies also walk on their fins along the sea bottom. The climbing perch uses its fins

for climbing and scrambling, and is said to be even able to climb trees.

TRAVELLING FISH.—Some fish, such as salmon and herrings, travel regularly every year, like birds of passage, from one part to another, when the time comes for spawning. Salmon leave the sea—mostly in autumn—and come to rivers and streams to deposit their eggs. There is great excitement among the herring fishers when a shoal of travelling herrings comes in sight.

AGE OF FISH.—Fish do not seem to be very intelligent animals; and the brains of a pike weigh only the 1305th part of the entire fish! Yet the mother salmon's careful choice of her spawning ground, the stickleback's building of a nest, and the love of fighting seen in many fish, seem to show that their brains are not asleep. Those which grow slowly live to a very great age. Carp and pike are said to live more than 100 years. A carp can be frozen in a block of ice and survive the trial.

TEETH.—Fishes' teeth are shed and replaced all through their lives. A carp has no teeth in its mouth, but further back in its throat it has a kind of mill, furnished with teeth for grinding water weeds and other vegetable stuff on which it feeds.

AIR BLADDERS.—Many fish, but not the flat fishes, have air bladders inside them, like hollow bags full of gas, which can make the fish heavier or lighter according to the weight of the water in which it finds itself. And all have hearts.

ROE.—If you have eaten mackerel or herrings you know what a quantity of eggs one fish can have in its "roe." It is said that the roe of a herring may have 25,000 eggs, though I do not know whether anyone has ever had the patience to count them. Truly the

command has been obeyed, "Let the waters bring forth abundantly the moving creature that hath life."

If you have played on the sea-shore you have probably come across the hard empty cases called "mermaids' purses" or "fairy purses," in which the eggs of sharks, skates or other fishes were contained. They have sort of strings or ribbons at the corners which twine around the seaweed.

SCALES.—If you take a fish in your hand you find it very smooth and slippery. This smoothness helps it to glide through the water easily; and you know how an eel, for instance, can wriggle into a very small crevice and burrow in sand and mud. The quaint-looking globe fish floats in the water. Different fish have differents sorts of scales, and if you could look at various scales through a good microscope, I think you would be surprised to see the many different shapes and patterns. Even the age of the fish is often registered on its scales, which have rings of growth like those on a tree trunk.

COLOUR. — Salmon feed altogether on "crustaceans," that is to say, crabs, lobsters, and their relations; and it is thought that their red colour (which comes out in these creatures when boiled) gives the fish its "salmon colour." In very many cases the colours of fish match their surroundings. Flat fish look like the sand on which they rest at the bottom of the sea. Fish which are kept in captivity, such as the gold fish of East Asia, which you see in glass bowls in houses, tend to become yellow.

STICKLEBACKS.—In almost any streamlet or pond we may come across that little spiny fish, the stickleback. We can easily catch it in a net, and let it go again after we have examined it well. Sticklebacks are great fighters, especially when defending their

young, and after a battle you will see the conqueror fish glowing with bright colours, his back shining green, his sides and head yellow and scarlet, and underneath silvery white ; while the stickleback which has been defeated seems to turn dark and dull. They devour litters of young fish, fish spawn and water insects. They are among the very few fish which build nests for their young. The nest is very tiny, made of bits of

STICKLEBACKS.

straw, stick, gravel, etc., and the fibres of leaves and stems entwined and stuck together ; it is laid at the bottom of the water, and is very difficult to see as it looks so much like the ground on which it lies. The male stickleback builds it in the month of May, and then invites his lady in the most amusing way to take possession. He defends his little ones, and drives them back to the nest if they go astray. The three-spined and ten-spined sticklebacks are the most common fresh-water kinds: the fifteen-spined stickleback is much larger than our little freshwater specimens ; it lives in

the sea, where it builds a nest of seaweed, often entwined among the branches of living corallines.

SEA-HAGS AND LAMPREYS.—Some of the most simply made fish—which, indeed, are hardly fish at all—are the sea-hags and the lampreys or "sucking fish," which you can find sometimes in streams, and which are so called because they can stick themselves to stones or other substances with their rounded mouths. They have no bones. But simple as they are they might boast to us of their long descent, for they are supposed to belong to a very ancient family.

> "O Lord, how manifold are Thy works!
> In wisdom hast Thou made them all:
> The earth is full of Thy riches;
> So is this great and wide sea also."

Questions

1. How does a fish steer itself?
2. What is the use of the paired fins?
3. How are the eyes of a flat fish arranged?
4. How many joints has a perch in its backbone?
5. How does a fish breathe?
6. What is the use of the air bladders possessed by some fish?
7. What has a carp instead of teeth?
8. Mention some particular fish which use their fins in different ways?
9. What are "mermaids' purses?"
10. How are flat fish coloured?
11. What kind of fish builds a nest and defends its young?
12. Name two kinds of the most simply made fish?

MAY 15

A Large Family

DANDELION A COMPOSITE.—We are going to look for some very common flowers to-day; it will not take us long to find them. Here they are, growing in the fields and by the roadside. Why, just a dandelion! what can there be to learn about such a common plant? Well; we shall soon find that there is a good deal to notice. And first, let us see how it is made.

If we pick one and pull it to pieces, we shall find that what we believed was one flower, is really made up of a number of flowers, each perfect in itself. This shows that our friend dandelion, though we thought so little of him, really belongs to a very large and important family; indeed, his relations are supposed to number about one third of all described plants! The learned people who study plants tell us that he belongs to the family of the composites, which means a *composition*, or making up, of a number of separate little flowers.

THE CALYX AND SEED.—Notice first the covering outside of narrow green leaves; this makes a little envelope or case ("involucre") for the flower, as you might put a letter into an envelope to keep it safe. Then come the florets, or little separate flowers, from 100 to 200 in number, each made up of four parts. First, the calyx or flower-cup. You know the hairy "thistle-down," which is left behind when the dandelion petals are all dead, and which you can easily blow off its stalk; that is just the dandelion seed, with its white fluffy calyx round it. You see, the seed is the most precious part of the plant, and so, what care is taken of it! Wrapped

up and tucked in so carefully, first in its own downy covering, and then kept safe in the outside green envelope.

But there is something else to notice about the hairs. They are like little wings to carry the seeds about when the time comes for them to be scattered, for they make the seeds light, so that it is easy for the wind to blow them in all directions, as the farmer knows to his cost.

Dandelion Seed.

ATTRACTION OF INSECTS. — The yellow showy leaf is called a petal, and all the petals together make up the corolla, or little crown. In most brightly coloured flowers the corolla or flower-head is the showy part, and, as we shall notice again, it is like the brilliant advertisements which shopkeepers sometimes hang outside their shops to attract customers. The bright colours and sweet smell of the flowers entice the insects to visit them and suck their honey, and insects carry about from one flower to another the pollen which will make the seed grow.

HONEY.—Dandelion has a great deal of honey, which is placed very high in the floret, so that he provides very good meals; and a man who took trouble to notice has counted ninety-three different kinds of insects visiting a dandelion plant.

DAISY.—A daisy, which is a sort of first cousin to a dandelion, has two kinds of florets; the white

ones,which are strap - shaped just like dandelions, and the yellow ones in the middle which are tube-shaped.

STAMENS AND POLLEN.—But we have not yet finished with our dandelion. In the middle of the petals are the stamens, looking like little tubes; these stamens hold the yellow grains of pollen dust, which have to reach the seeds before the seeds can grow. On a rainy day you will find dandelion closed, as if he had gone to bed! He will have shut himself up tight, so that the rain may not wash his pollen. And on fine evenings he closes about five o'clock, opening again about seven next morning; while his cousin daisy opens at sunrise and closes at sunset, thus winning the pretty name of day's eye.

PISTIL.—In the very middle of the stamen we find a very thin long stalk, with two little curved hooks at the top, each like the curved hook of an umbrella handle. This is the pistil, and at the bottom it is fastened into that tiny white box which holds the seed, which we noticed just now surrounded by fluffy hairs. Before the seed can ripen, the pollen has to travel down the pistil and touch the seed. Sometimes insects carry the pollen from one dandelion to another; but if insects do not happen to come, those curved hooks bend right over until they touch their own stamens and get brushed with their own pollen.

MOVEMENTS OF DANDELION.—I must tell you of some curious movements of the dandelion. At first the stalk stands straight up, for about three or four days, till the plant is full blown. Then it lowers itself, and lies more or less flat for about twelve days while the seed is ripening. When the seed is ripe it rises again, and stands ready for the wind to come and scatter the seeds broadcast. The leaves of the green outside envelope, some of which were before folded around the

seeds, now turn back and hang down, making room for them to be scattered.

ROOT.—As a rule it is not at all a good plan to pull up flowers by the roots, but in the case of the dandelion we may do so, for our friend is a troublesome weed. We will therefore pull him up and see what his root is like. We shall find that it is a "tap-root," that is, it goes straight down into the ground like a stake; it is very thick, and very dark, and if you put your tongue to the milky juice which oozes from the stalk you will find it very bitter. This bitter liquid is a valuable medicine, used in dropsy and liver complaints. The name dandelion, from the French "dent de lion," lion's tooth, is given on account of the toothed edges of the leaves.

OTHER COMPOSITES.—We have already noticed a first cousin of dandelion, the daisy. Shall we try to find some other relations? You know if we are looking for members of his family, the "composites," we must try to find flowers which are made up of little separate florets. Ah, here is one with a strong family likeness, a coltsfoot. Its grand Latin name, "Tussilago," from "tussis," a cough, is given because a medicine made from coltsfoot has long been used in chest complaints. Here on the banks of a stream we find some more relations, the butterburs. The flowers, which come out before the leaves, are not very pretty or interesting to look at, but they are very welcome to the bees, for they appear in March before many other flowers are out. Probably you know the flat leaves on the high stalks, and perhaps call them "umbrellas"? I have seen pictures of them in fairy-tale books with elves sitting upon them!

Can we find any other members of the family? If you have a canary bird, or if you ever weed a garden, there is one "composite" you must know very well, the common groundsel which Dicky enjoys so much.

We may find ox-eye daises, and another relation, yarrow or milfoil, common not only in Great Britain but all over Europe and Russian Asia, from the Mediterranean to the Arctic Circle. Here too are the meadow salsify or yellow goat's beard; and the mouse-ear hawkweed with its lemon-coloured flowers.

FOREIGN COMPOSITES.—Beside all his British relations, which will appear more and more as the summer goes on, dandelion has some foreign allies which you see in gardens. If you think about it you will soon remember his cousin marigold, sunflower, Jerusalem artichoke, chrysanthemum and dahlia. The yellow and white chrysanthemums come from Africa, and the late autumnal kinds from China.

THE ELIXIR.—And so we have found bright yellow "weeds" seeming to scatter the fields with gold. And the poet George Herbert tells how we can take our common little everyday duties and turn them all into gold if we choose.

"Teach me, my God and King,
In all things Thee to see,
And what I do in anything
To do it as for Thee. . . .

A servant with this clause
Makes drudgery divine;
Who sweeps a room as for Thy laws
Makes that and the action fine.

This is the famous stone
That turneth all to gold,
For that which God doth touch and own
Cannot for less be told."

Questions

1. To what family does a dandelion belong, and what is the meaning of the family name?

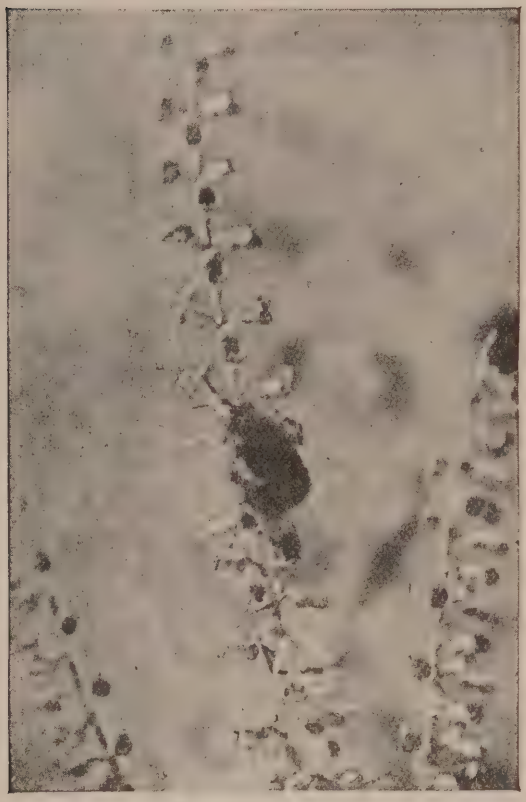
2. What is the white fluffy part which is left when the dandelion's petals are dead?
3. What are the names of the two different kinds of florets in a daisy?
4. What do the stamens hold?
5. What is the dandelion's pistil like?
6. What happens to the leaves of the green case around its corolla when the seeds are ripe?
7. What kind of root has a dandelion?
8. Name some other English composite flowers.
9. Name some foreign ones.

JUNE 1

Carrier Insects

POLLEN FERTILISING SEED.—To-day we will look at a few more common flowers, and there is something I want you to notice about them all. It is, the way that insects do them good by helping the seed to ripen. What do I mean by that? Well, you know that we saw how the seed in the dandelion seems to be the most important part of the flower, for it is the most carefully guarded, and wrapped up safely in two coverings. And you will remember that before the seed can ripen, the pollen from the stamens has to travel down the inside of the pistil and touch it. But the curious thing is that in almost every flower, its seeds become better and stronger and more plentiful if they are "fertilised," or made to ripen, by pollen from another flower of the same kind, than if they are touched by the flower's own pollen.

INSECTS CARRY POLLEN.—So you see, if the pollen is carried about from one flower to another, the seed is more likely to be healthy, strong and abundant. But who are to be the carriers? Sometimes the wind, but more often insects. We said that sometimes insects visit the dandelions and carry about their pollen. When this does not happen, the dandelion stamens will bend over and brush their own pistils.



Humble Bee on Wood Sage.

SELF-FERTILISATION PREVENTED. — But in the flowers which we will consider to-day there are all kinds of "dodges"—so to speak—for preventing each flower from fertilising itself with its own pollen.

STRUCTURE OF DOG VIOLETS.—First we will find a dog violet and pull it to pieces. We will look, to begin with, at its petals. You see they are not all alike; one petal is drawn out into a sort of long spur, which is hollow, and partly covered over at its entrance by the top of the pistil, partly by little tufts of hairs. Now we must look for the stamens which hold the pollen. Ah, here they are! They have short stalks

with the pollen-holding part (called the anthers), at the tops of the stalks. And see—the two lower stamens have long spurs also, which fit inside the spur of the petal.

HONEY AND POLLEN.—Do you know what the insects would find at the further ends of these spurs? They would find some nice sweet honey stored there for enticing the bees to come and visit the violet. There is a hollow space—a sort of box for catching the pollen—between the stamens and the pistil. You know a violet hangs down its head. And its pollen is very dry and falls out of the anthers very easily. So, as the flower's head is always drooping, it drops its pollen into the little box between the stamens and the pistil.

VISITS OF BEES.—Now here comes Mrs Bee poking her tongue into the spurs of the stamens to find the honey. She is sure to knock her head against the top of the pistil, for the pistil has a very thin, shaky, bent sort of stalk. So she will knock open the little box which had caught the pollen fallen from the stamens, and the pollen dust will tumble on to her head. Then, when she flies off to visit another violet, she will carry the pollen with her, and leave some on its pistil.

But will she visit another violet? May she not fly off now to some other sort of flower? No, she will almost certainly go to another violet, for it has been noticed, curiously enough, that whatever sort of flower a bee starts with, she will almost certainly remain faithful to that particular sort for the rest of the day.

FOXGLOVES.—There are some kinds of flowers which can only be fertilised by particular kinds of insects. Foxgloves, for instance, can only be fertilised by humble bees, because no other insects are large enough to fill the bell of the flower and get the pollen on to the pistil.

FOXGLOVES.

RED CLOVER.—In this red clover the honey is placed very low down in the tube of the flower, but the long tongues of the bees can reach it; though sometimes the lazy bee bites a hole in the bottom of the flower to get at the honey without troubling to send her tongue down the tube. You will find the bottom of the floret very sweet if you pull it out and taste it.

INSECTS' TONGUES.—Insects' tongues are made to suit the flowers. I daresay you have seen a fly poke out its little trunk and suck a crumb of sugar on the breakfast table? Well, hive bees and humble bees have very long tongues which they can push down to the very bottom of the flowers to suck up the honey; and the tongues of many butterflies and moths are longer still. A butterfly's tongue is wound round and round under its mouth, and is very much like the mainspring of a watch; then when it settles on a flower it unwinds its tongue and shoots it out into the flower tube in search of honey.

FREQUENT VISITORS.—Many different sorts of two-winged flies, and a few other kinds of insects, visit flowers, but they are mostly visited by bees, butterflies and moths. This is why a bee keeper will tell you that bees are very good for flower gardens.

WILD GERANIUM.—But now let us look for another wild flower. Here is a capital one to study, because it is so simply made—a wild geranium or meadow crane's bill, which has just flowered. You see it has five great showy purplish blue petals, which insects could easily see, like a coloured advertisement hanging outside a shop, with big letters saying, "Come in and buy!" The honey which geranium is offering to the insects is in five little glands (honey pots, if you like to call them so) near the bottom of the stamens, and little fingers of hairs are arranged just above

them—like little umbrellas to prevent any rain, and also perhaps small insects, from getting in and spoiling the honey.

HONEY GUIDES.—If you were going along a road which you did not know, you would be glad to come upon a sign post pointing out the way. Now let me show you something very curious. These pretty purple lines on the petals point straight to the honey bags, and are supposed to be "honey guides" to show the insects the way to the honey. But it is interesting to notice that those which only open at night and are fertilised by night moths have no honey guides, because the lines could not be seen in the dark.

STAMENS AND PISTIL.—Now count the stamens —ten—and do you see that they are not all alike? Five are taller than the others.

And here is the pistil, with its five stigmas, or little tops, all shut up and closely pressed together. The flower has only just opened, and the pistil is not yet ready for the pollen.

At present the stamens are all lying flat on the petals. But if we can find a rather older geranium, which has been open longer, we shall find its five outer stamens standing up round the closed pistil and shedding their pollen. A little later they will lie down flat again, and then the five inner stamens will rise up and shed their pollen in the same way. When all this is over, and the pollen is shed, the anthers or pollen bearers will drop off, and the pistil will open at last and unfurl its stigmas.

THE INSECT CARRIERS.—But how will it get its pollen? Will it not be too late, as it has taken so long to open, and the pollen has all been shed? No, because busy insects will come to the rescue. They will fly from one geranium to another, carrying the pollen from a younger flower where only the stamens are ripe, to

another where the pistil is ready for it. So here is a case where a flower could not possibly fertilise itself.

HERB ROBERT.—But meadow crane's bill has a little brother which I expect you know well—herb Robert. He is much smaller, as you know, than his big relation. He has no little umbrella hairs to protect his honey, as he is less open and exposed to the wet, and his honey bags are enough protected by the stamens and pistil. This flower has a disagreeable smell, especially when pressed, and is much visited by flies which do not object to smells which to us are disagreeable. After the flower has faded, the middle part which holds the seed lengthens out into a kind of rod or pillar, and when the seeds are ripe they are jerked out from the base of the rod to a surprising distance, as if shot out by a pop-gun.

TWAYBLADE.—We might take many walks without nearly coming to an end of all that is to be learnt about the way insects fertilise flowers. If we only studied the different sorts of pollen, and nothing else, it would give us plenty to think about. The pollen of the twayblade, to take one instance, is very curious ; it is so crumbly that it could not stick to insects of itself, but the moment that the insect touches the part where the pollen lies, a large drop of sticky fluid oozes out and glues the pollen to the insect. You can see the sticky stuff for yourself, if you touch a twayblade in the part below the pollen with a hair or blade of grass.

COMPOSITES MUCH HELPED BY INSECTS.—We have seen that dandelion's family, the composites, is a very large one. Of course as a composite flower is made up of a great many little florets, it is much more easily seen by an insect than a single flower would be. Also, the visits of an insect are very likely to take effect, as when it alights on a composite it touches several flowers at once. So that the composite family is very flourishing, being helped forward by insect visitors.

SCENT OF FLOWERS.—Many flowers no doubt attract insects by their smell as well as by their colours. Here is an old friend, Ragged-Robin; he has no scent, but his bright red colour will doubtless attract the butterflies. His sister, the white lychnis, only opens at night, and so a bright colour would be useless to her, but she gives out a slight scent in the evening, to attract night-flying insects.

MUTUAL HELP.—We see then how insects and flowers help each other, without knowing it. Now you and I have a better reason for helping our neighbours—the best reason of all; for we may "bear one another's burdens, and so fulfil the law of Christ."

Questions

1. What does the pollen in a flower do for the seed?
2. How do insects help on the fertilisation of flowers?
3. Where is the honey stored in a dog violet?
4. What does the pollen fall into from the violet's anthers?
5. When a bee visits the violet, what happens to the pollen?
6. How do we know that the bee will go on to another violet?
7. What sort of tongues have bees and butterflies?
8. Describe the structure of meadow crane's bill.
9. How are the stamens arranged in (*a*), a young crane's bill; (*b*), in one a little older; (*c*), in one older still? and what finally takes place with regard to its pistil?
10. How do the insects help its fertilisation?
11. Why are the composites so much helped by insects?
12. How do flowers attract insects to search for their honey?

JUNE 15

Beautiful and Good

WILD STRAWBERRY.—When we cut open an apple we saw how the fruit was formed from the calyx tube and ovary of the apple flower. We will find another kind of fruit to-day, a kind which most people like even better than an apple, I mean a strawberry. Strawberry is really first cousin to the apple tree, for he belongs to the same great rose family.

We will look first at this wild strawberry flower. We must not mix it up with the little barren strawberry or strawberry-leaved cinquefoil yonder, which is very like it, and which belongs to the rose family also; but we can always tell the difference by noticing that in barren strawberry the flower stalks lie along the ground instead of standing upright, and its petals are short and notched.

THE STRAWBERRY FRUIT.—Now let us pick off from the strawberry flower the green calyx leaves, the five white petals, and the yellow stamens; what is left? A little hard, green lump, which we might call an unripe strawberry! Let us search a little further on the bank; ah, here is a ripe strawberry. You shall eat it, and you tell me you have eaten the fruit. And so you have; but strictly speaking, the *real* fruits were the tiny hard brown grains dotted about the strawberry, for each of those tiny grains is a little seed vessel holding a seed. And if you look closely, especially in a large garden strawberry where they are more easy to see, you will find a number of tiny dark threads, like hairs, also scattered about in the fat juicy part. These are the stalks belonging to the pistil of the flower which has withered away. The leaves of the calyx or outer

flower cup are still clinging, you see, round the red strawberry.

Sometimes you may find one strawberry plant showing all its different stages—two or three flowers, and then the green "receptacle" as it is called, beginning to swell, with the little brown pistil leaves covering it, and then the ripening strawberry.

RUNNERS.—Strawberry plants throw out a quantity of runners which creep along the ground, and keep on forming fresh roots and thus making new plants. There are strawberry plants very like ours in South America, and another kind in the Himalayas. Our garden strawberry comes from cultivating the hautbois strawberry, which grows chiefly in Eastern Europe.

GREEN FRUIT.—We noticed that the strawberry "fruit," the part that we eat, begins by being green, and then as it ripens it turns red. It is curious that green unripe fruit behaves very much as green leaves do. In daylight green fruits take in carbon dioxide and throw off oxygen; when night comes the exact opposite takes place, they take up oxygen and throw off carbon dioxide.

RIPENING.—As the fruit ripens, it becomes coloured and changes a good deal; the bitter sour acids disappear, and so does the starch of which some green fruits are full; and it is found to contain a great deal of sugar. At the time when the fruit is just ripe, and good to eat if eatable, it gives out carbon dioxide only, and no oxygen.

FRUITS.—We often talk about fruit as if it only meant something that we can eat, such as apples, oranges, peaches, or strawberries. But as a matter-of-fact all flowering plants bear fruit, and there is a great deal of fruit that we should never think of eating. In some cases it is rather puzzling to know which part is the real fruit if we have never studied the matter.

We have seen that in the strawberry plant the real fruits are the little brown grains scattered about over the part which we always call the "strawberry." But in the raspberry and the blackberry, the nice part which we like to eat is made up of a quantity of little fruits (drupes as they are called) all joined together; and the hard middle part which we throw away in the raspberry answers to the juicy red part which is just what we eat in the strawberry.

DANDELION FRUIT, AND PINE CONES.—Where is the fruit in a dandelion? It is the little white seed

Pine Cones.

wrapped up in its tiny calyx-case at the bottom of the pistil, with a long thin stalk crowned with soft white woolly hairs so that the wind can blow it about easily and scatter it far and wide. And here we find quite a different kind of fruit. This pretty pine cone is a fruit, very dry and hard; pull off some of the woody scales, and you find clinging to each scale a winged seed, which the wind can blow to a long distance because it is so light.

DISPERSION OF FRUITS.—Fruit then is seed with its covering, belonging to any flowering plant. There

are many different ways in which fruits are scattered. Some are blown by the wind, as we see; some are carried by rivers, streams, and ocean; others, like burdock seeds, have hooked scales which cling to animals' coats and the clothes of people and are thus carried about; a few, such as the balsam ("touch-me-not") seed vessel, burst open and shoot out their seeds like a pop-gun; and others, like many of the berries, attract birds to swallow them by their sweet taste and bright colours, and thus get their seeds dispersed.

BLACKBERRIES.—We mentioned blackberries, which also belong to the rose family. Blackberry brambles are rather interesting as being "hook-climbers." You find this out to your cost if you go blackberrying in autumn and tear your clothes! Their strong prickles grow from the skin of the stem, like hairs, not from the wood as do the thorns of hawthorn. The brambles can climb up through tangled thickets with the help of these hooked prickles. In the autumn their long stems often arch over till they touch the ground, and the tips root themselves firmly in the earth, and make fresh plants. Thus the plant may travel onward 20 feet or more in a year, or climb a 10 foot wall, creeping along, as it were, in the air, while the strawberry throws out runners along the ground.

FRUIT A PARABLE.—Let us think once more of the little parable by which we may learn from fruit. Our Lord told His disciples, and He tells us, that He has "ordained us that we should go and bring forth fruit;" and we know that this means "the fruit of the Spirit: — love, joy, peace, longsuffering, gentleness, goodness, faithfulness, meekness, self-control."

Questions

1. What is the difference between the wild strawberry and cinquefoil?
2. What are the real strawberry fruits?
3. What are the leaves which hang round the bottom of the red strawberry?
4. How do strawberry plants form fresh roots?
5. Whence comes our garden strawberry?
6. What changes do green fruits pass through as they ripen?
7. Of what is the eatable part of a raspberry made up?
8. How are pine seeds scattered?
9. Name some different ways in which fruits are scattered.
10. How do the blackberry brambles travel?

JULY 1

The Nymphs of the Lakes

NYMPHS.—People in old days used to tell fables of beautiful beings whom they called nymphs, who were thought to live under the water in lakes and fountains, coming to the surface sometimes and showing themselves to wondering mortals.

We will go down to the waterside this afternoon, and though I do not think we shall find nymphs looking like beautiful maidens, still we may come upon

something very pretty to look at, called "white nymphs" by the learned people who give grand Latin names to the flowers.

WATER-LILIES.—Here is one of the pretty things I mean—a white water-lily; and there are some yellow ones too. She is floating a little way off from the shore, and we have no boat to take us nearer to her, but that does not much matter, for she is so large and fine that we can see her well from the land.

STRUCTURE OF A WATER-LILY.—What beautiful snowy-white petals! and inside them a golden crown of great yellow stamens, surrounding the tall fat pistil in the middle.

Plenty of room for insect visitors here, and it is thought that the water-lilies are fertilised by beetles and flies. A water-lily—whether yellow or white—is really a very simply-made flower, and has none of those wonderful plans or contrivances for storing up and saving the pollen, and making the most of an insect's visit, which you find in a little dead-nettle or violet, for instance. The water-lily has plenty of pollen and scatters it freely.

TROPICAL WATER-LILIES. — But though our nymph is so simple, she is a very interesting flower as well as a beautiful one. She has a very lovely sister in Tropical Asia. And she is also the small relation of a very grand and important personage, the "Victoria Regia" water-lily of South America, which you may see in a great tank if you go some day to Kew Gardens. Its flowers, which pass from pure white to rose and pink, are sometimes 15 inches across; and it has enormous leaves, green above and crimson beneath, rather like those of our water-lilies in shape, but often measuring from 10 to 12 feet across; they are turned up at the edges, looking like gigantic tea trays in shape, and are so broad and strong that a little child

could sit comfortably on one without sinking it under the water. Water birds pass the night upon them. The Indians have a fable that their god Vishnu crossed the eternal waters on a water-lily leaf.

WATER PLANTS.—If you notice the breadth of the water-lily flowers, and their flat, wide leaves, you will see there what is to be found in most water plants. They have broad surfaces so that they are able to take in plenty of gases from the air above, and plenty of water from below and around, to feed and nourish them. It has been suggested that perhaps the butterbur, with its great leaves, was once a water plant. It still loves moist places.

ROOTS.—Again, land plants are held up in the ground by their roots, and are partly fed through them. But as water plants float, and also as they take in food from the water, their roots, when they have them, are useful chiefly as anchors.

OUTER COVERING.—The outer skin or covering of a land plant is more or less waterproof, but a water plant sucks in moisture on all sides.

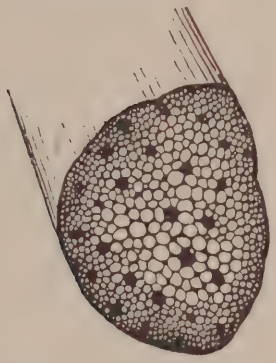
STOMATES.—If you take a bit of the leaf of almost any land plant, and put it under a strong microscope, you will find it sprinkled with little mouths, or "breathing holes" as they are called, for taking in gas (carbon dioxide). You remember that we spoke of this in our lesson on a potato. In most plants these cells or mouths are on the under sides of the leaves. But as the under sides of water-lily leaves of course touch the water, its mouths are all on the upper surface.

TISSUES.—A water plant has also very much fewer tissues than a land plant, for strengthing and supporting it, as it is held up sufficiently by the water; and so its stem is more flexible and yielding. The stalks of the

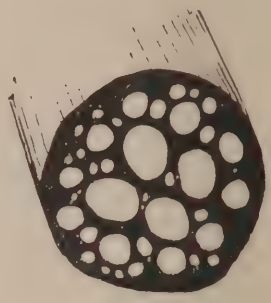
flowers and leaves of the water-lily are crossed and re-crossed by fine air-cells.

SLEEP OF VEGETABLES.—The water-lilies, as I am sure you have noticed, close themselves up towards evening. The white water-lily seems to be "awake" from about seven to four. In the bright sunshine they open out again, as if to say, "Here we are! you can see us now. Come, beetles, and find our pollen."

YELLOW WATER-LILIES.—The yellow water-lilies are not such pleasant acquaintances as the white, for



Stem of Yellow Water-Lily.



Stem of White Water-Lily.

the flowers smell disagreeably of brandy, and in Norfolk and some other parts they are called brandy bottles. The Turks make a cooling drink from the flowers, which they call pufer.

USES OF WATER-LILIES.—The roots of some kinds of water-lilies are good to eat, and the seeds being full of starch can be eaten also. The seeds of Victoria Regia and of the sacred lotus, venerated by the Bhuddists, are eaten under the name of water maize. A grey dye is made from the stems of the white water-lily. As the water-lily leaves before unfolding are twisted into a shape like a vase, they are often called water-cans.

REED BEETLES.—The queer little reed beetle[1] is very fond of clinging to the under side of a water-lily leaf, and the silky down on its body keeps it from getting wet. It is a mischievous visitor, for it gnaws the petals and stamens, and its larva has two spines, with breathing holes, at the end of its body, with which it probes the water-lily roots.

THE AUTHOR OF BEAUTY.—Our beautiful nymphs may remind us of a verse of a hymn which I hope we know well:—

> "All things bright and beautiful,
> All creatures great and small,
> All things wise and wonderful,
> The Lord God made them all."

Questions

1. What is the name of the great water-lily of South America, and what are its leaves like?
2. Why are the leaves of water plants generally broad?
3. When water plants have roots, for what are the roots chiefly used?
4. What is the difference between the outer skin of a land plant and a water plant?
5. Where are the stomates placed in water-lily leaves, and why?
6. Why has a water plant fewer tissues than a land plant?
7. What happens to the water-lilies towards evening?
8. Name some uses of water-lilies.

[1] Donacia crassipes.

JULY 15

Ships of the Air

"'Tis always morning somewhere; and above
The awakening continents, from shore to shore,
Somewhere the birds are singing evermore."

LONGFELLOW.

SWALLOWS AND MARTINS.—Perhaps nothing speaks to us more strongly of summer than the sight of the swallows skimming hither and thither in their happy, busy quest after insects. We cannot catch one to examine him, but as he flies by us we will look at him as closely as we can.

I expect you know the chief difference between a swallow and his cousin a house-martin? A swallow is larger than a martin, and has a deeply-forked tail, with very long feathers at the edges which are two-thirds the whole length of the bird. He has a bright chestnut-coloured patch on his throat, a chestnut band across his forehead, and his feet are bare. He is steel-blue on the upper part of his body and wings. Cousin house-martin is very like him, but is pure white underneath, and has a large white patch on the lower part of his back, which you can see very easily as he flies about; and he wears feathery stockings on his legs.

SAND-MARTINS.—The sand-martin, which builds nests in holes which it makes in cliffs and rocks, is darker, for it is of a greyish brown colour above, though it too is white beneath. It works very hard at building its nest; it holds on to a sandbank, or the side of a cliff, with its claws, and works away with its bill, rather like a miner with a pickaxe. In this way it makes

House-Martin.

round holes, and tunnels two or three feet deep, which it lines with hay and feathers. The sand-martins are brave little people, and will "mob" and attack larger birds, even hawks.

NESTS.—You know that the house-martin builds its nest generally under the eaves of houses and buildings, and the swallow in chimneys and all sorts of queer places. You remember a beautiful verse in the Bible where the Psalmist notices a swallow which had built her nest in the temple?

> "The sparrow hath found her an house,
> And the swallow a nest where she may lay her young,
> Even Thine altars!" (Ps. lxxxiv. 3).

The house-martin often uses earth-worms' "casts" for its nest. The martins take much more trouble over their nests than the swallows, which make very rough little abodes of mud or clay lined with feathers and other soft things, finishing them in about three days. The swallows' eggs are spotted, and those of the martins pure white. It has been suggested that the shiny whiteness of the eggs of the sand-martin is a sort of "guiding lamp" to the parent birds, at the end of the long tunnels and deep holes in which they are laid.

SWIFTS.—There is a kind of bird not very unlike the swallow and martin, which is often supposed to be more closely related to them than is really the case. I mean, the swift, who really belongs to a different family, and is a near relation of the humming-birds, though he looks so much like a swallow. Yet you could almost distinguish him from the swallows, even at a distance, by his very long, narrow wings, and his peculiar flight, which is more like that of a bat than a bird. The ends of his wings reach more than an inch beyond the tip of his tail; and he does not flap

them so often as the swallow, but goes more as if shot from a bow, making great use of his tail in flight. If you examine him closely you will find him sooty black, with a grey patch below his chin.

You have probably noticed that the swifts seem most active in the twilight. For about half an hour after sunset they will all cry and twitter together in a sort of concert, before beginning their last good-night fly around before bedtime.

WINGS.—Their wings never seem to tire. Having such very short legs and long wings, it is difficult for them to walk along the ground, or to rise from it if they have once settled, so they spend the long summer days on the wing, except when they shoot into their nests to feed the little ones who are not yet old enough to fly. And their nests, made of straw, hay, etc., cemented with glue from their own glands, are stuck on walls, in steeples and other high places, where they can dart in and out without having to settle on the ground.

FEET.—Swifts have all their four toes directed forwards, instead of having one toe (answering to our thumb) turned backwards, as is generally the case with perching birds. So they can climb walls easily and stick their nests to them.

BIRDS' NEST SOUP.—I daresay you have heard of birds' nest soup, which the Chinese so much enjoy? It is made from the nests of the "esculent" (that is, eatable) swift of the Malay Archipelago and other tropical parts. The nests look just like little saucers made of brittle material like frosted sugar; and the soup is supposed to be extremely nourishing. The nest is made of juice from the bird's mouth.

FOOD OF SWALLOWS.—And what do the swifts, swallows and martins themselves feed upon? Well,

you know their bill of fare for breakfast, dinner and supper is entirely of insects—leg of fly, shoulder of gnat, beetle-joint, etc.! And so in order to supply themselves with this airy food they need three things which they possess to perfection—keen eyesight, strong wings and wide mouths. Swifts especially have very wide "gapes," as they are called. It is often said that when they fly close to the ground it is a sign that rain is coming, for in fine weather the insects which they seek seem to rise higher in the air.

MIGRATIONS.—This need of seeking insects, in warm weather, is the secret of their wonderful journeyings, when they follow the summer out of one land into another; guided by that instinct which has been called "God's thinking, not their own." Generally by the end of August the swifts have all left us for warmer climates in South Africa and Madagascar. The sand-martins, which arrive early in spring, leave early also for India and Africa. They are common in North America in summer, going off to Mexico and Central America as winter approaches. Swallows have been seen as far north as Spitzbergen, migrating to Asia Minor and Arabia. House-martins fly off south of Abyssinia, but they linger with us later than the swallows, which desert us in late summer for Africa and India. It is curious that when migrating they always fly in a line directly north and south.

MOULTING.—Many birds moult in autumn, but swallows moult in spring, so that their migration is not hindered. When moulting, their quill-feathers drop out in pairs; otherwise they would become lop-sided and lose their balance in flying.

SHAPE OF WINGS.—If you study a swift or swallow you will find it is altogether a wonderful flying-machine! Think of the shape of its wings, long, narrow and pointed, so as to cleave the air, rather as

the long, narrow blade of an oar cuts the water. You know that a bird which does not need to fly high or far, such as a barn-door fowl, has rounded wings. Then when the swallow is flying, his wing is arched like an open umbrella, so that the air presses into the hollow part of the wing and pushes him upwards and forwards, but it escapes and falls away from the outside arched part and does not hinder his progress.

FEATHERS.—Take this feather and rub it between your finger and thumb from the tip downwards; the little barbs or hairs come apart and separate; now smooth it upwards, they easily shut together again. So when the bird strikes his wings downwards, the feathers close up together and resist the air which presses against them; but when he flaps his wings upwards again, the feathers open and separate, and the air escapes through the meshes. And if you looked at the barbs of this feather through a microscope, you would see them covered with little hooks, called barbules, which hook into each other, and make each feather of the wing more firm and close. Feathers are of use to the bird for warmth, for decoration and for flight.

BONES AND MUSCLES.—Swifts and other far-flying birds have very strong breast-bones, with powerful muscles to work the wings. If you carve a roast chicken or pigeon, you see that the most fleshy part is round the breast-bone, which is supplied with these muscles; you would find it specially so in a flying bird like a pigeon. Birds are so light, strong, active and beautiful that they take a very high rank in the animal kingdom.

MAKING FRIENDS.—It is both cruel and foolish to kill little birds such as swallows and martins, which are useless as food, beautiful to look at, and do us good service in ridding us of harmful insects. Much better and more interesting if, instead of killing birds and

FEATHERS OF THE EAGLE OWL.

stealing their eggs, we try to tame them—I do not mean by shutting them up in cages, but by putting out food for them, and especially water, and by seeing that they have some comfortable hole or corner near our houses where they may come and build in peace. They may reward us by making friends with us after a little time!

"Are not five sparrows sold for two farthings? and not one of them is forgotten in the sight of God. Fear not! *ye* are of more value than many sparrows" (St Luke xii. 6-7).

Questions

1. Describe a swallow, a house-martin, and a sand-martin.
2. What sort of nest does each build?
3. What is the difference between a swallow and a swift?
4. How are swallows and swifts adapted for catching and feeding on insects?
5. Which migrate earliest—swifts, swallows or house-martins?
6. When do swallows moult, and why?
7. Why is the wing of a flying swallow arched, like an open umbrella?
8. What happens to the wing feathers when the bird strikes its wings downwards?
9. What is the best way to tame a wild bird?

AUGUST 1

A Transformation

DRAGON-FLIES.—In old times people had fables about certain strange beasts which they called dragons, and which were supposed to be very strong and very fierce, killing and eating all other living creatures, and even men, women and children which came in their way.

On this hot summer morning we are sure to see some of those insects flashing about over the water which have been named after dragons because they are so strong, and fierce, and prey on other insects. These beautiful dragon-flies are cruel hunters. We must do them the justice indeed to say that the nickname of "horse stingers" is unfair, for they never hurt horses.

THEIR STRUCTURE ADAPTED FOR HUNTING.—Now they need three things to help them in their chase, which we may notice they possess. They have long slim bodies (so that the French call them "Demoiselles," which means young ladies!), long wings to carry them quickly through the air, and large eyes to help them to see their prey at once.

INSECTS' EYES.—If you can come near enough to a live dragon-fly, or if you examine a dead one, you will at once notice his great eyes. The eyes of all insects are wonderful little instruments. That common house-fly which was buzzing around our heads just now has five eyes altogether; two large ones, which are called "compound," for each is made up of 4000 tiny cells or windows, rather like the cells of a honeycomb; and three little ones on the top of his head called "simple

eyes." A dragon-fly has 12,000 cells or windows in each eye.

INSECTS' WINGS.—And now let us admire the dragon-fly's wings, which are rather like beautiful pieces of fine lace. Indeed he belongs to an order of insects

A Dragon-Fly.

called "Nerve-Wings,"[1] because a great number of nervures or tubes are spread in a network all over their wings like the veins in a leaf. Insects' wings are often beautiful if looked at through a microscope, and are supplied with air-tubes and nerves. The little scales on a common gnat's wing form a pretty pattern, and

[1] Neuroptera.

there are many different sorts of scales to be found among the butterflies and moths.

VARIETIES.—One of the commonest kinds of dragon-fly is called "Libellula." (I think there is no English name for it.) The male has a lovely blue body, and the female is yellow. Some of our largest dragon-flies[1] are 2 or 3 inches in length, and also across the wings, and while they are alive their bodies are marked with blue, green and yellow, but the colours fade very soon after death.

Then there are the "Agrions;" here is one with purplish wings. I see among the rushes yonder one of our smallest dragon-flies,[2] only about an inch long, with a very slender body prettily marked with blue and black; he has a big brother in South America, the largest dragon-fly known, six or seven times as big as himself.

INSECTS' LIFE HISTORIES.—These Dragon-flies were just as fierce when they first began their lives as they are now. You know that most kinds of insects go through three stages. First, an insect is a grub or "larva."—You can show me one? this caterpillar of a butterfly. The word *larva* means a mask, and the larva-stage masks or hides what the insect will be some day. Then it changes into a "pupa," like the chrysalis of a butterfly, and in that stage it is sometimes wrapped up in a case, or buried under the ground, without moving or feeding, so that it is called a *pupa*, which means a mummy. Then at last it comes out as an "imago," or perfect insect.

DRAGON-FLY LARVA AND PUPA.—Well, do you know where friend dragon-fly passes through his larva and pupa stages? Why, in the water, and a very queer sort of larva he makes. I think I can show you one

[1] Æschinidæ. [2] Cænagrion puella.

here, and it would interest you if you could catch two or three and keep them in a glass globe of water for a time to watch their movements and study their strange mouths. Both as larva and pupa, it takes in water through its tail; the tail is made of several thin flakes which open out and allow the water to pass in and out;

BUTTERFLY HANGING FROM REMAINS OF A CHRYSALIS CASE.

the insect takes in the oxygen out of the water to breathe, as a fish does, and then squirts the water out again. This squirting movement pushes it along in the water. If you put a little sand at the bottom of the glass globe, you will see how the grains of sand are disturbed by the squirted water, as the insect moves itself along in the globe.

Both as larva and as pupa it has a very strange mouth, with which to catch its food; for its lower lip is

jointed, and when the insect is at rest, is folded flat over its face, as a carpenter's rule can be shut up and put away in one's pocket; but when the insect wants to catch anything it shoots the lip out, and grasps its prey with a pair of forceps at the end of the lip.

It remains like this for ten or eleven months, and you can easily tell the pupa from the larva, for the pupa shows the beginnings of the future wings on its back.

PERFECT INSECT.—When the time for change comes, the pupa crawls up the stem of some water plant, where it clings with its claws, shaking and trembling; then the skin of its back splits, and out come the head and chest of the perfect dragon-fly. By degrees it gets quite out of its old coat, and sits for a few hours drying itself, and shaking out the folds of its great wings. It breathes in the air, and at last flies off, a complete, and we may hope, happy, insect.

MAY-FLIES.—What is that curious thin stuff, looking rather like a dead insect, sticking to the stem of this water-plant? It is the old skin of a may-fly, which it cast soon after it came out of its pupa case. A may-fly is a near relation of a dragon-fly, and may-flies are the only insects which cast their skins in this odd way when they have passed the pupa stage. Sometimes they only wait an hour, sometimes about twenty hours, before settling on the stem of some tree or plant and getting rid of the pellicle which had covered their body and wings like a little cloak. Then their wings become brighter, and the three hairs or filaments which make up their tails become twice as long.

A may-fly passes two years in the water as a larva and pupa, hiding under stones, or burrowing into the banks where it makes a queer sort of double tunnel. Then out it comes to live as a "perfect insect," a very short time indeed—sometimes only a day. In France and elsewhere abroad there are white may-flies, which

come out from the water after sunset and die before sunrise.

TRANSFORMATION. — The dragon-fly passing through such strange changes, first a commonplace little larva and pupa masking what it will be some day, and then passing into a beautiful creature flying about in the sunshine with fairy-like wings, seems to be a little parable of the resurrection. "It doth not yet appear what we shall be," but we believe that one day our human bodies shall be changed, and "fashioned like unto God's glorious Body," when "this corruptible shall put on immortality."

Questions

1. How are dragon-flies adapted for hunting other insects?
2. How many eyes has a house-fly?
3. How many cells has a dragon-fly in its two eyes?
4. What is the order of insects called to which a dragon-fly belongs?
5. What are the three stages in an insect's life history?
6. How does the dragon-fly larva move itself in the water?
7. Describe its mouth.
8. How does the pupa change into the perfect insect?
9. How long does the may-fly live as larva and pupa and as perfect insect?

AUGUST 15

Watery Wonders

WATER-FLEAS.—Our last walk took us to the side of the water, to watch the dragon-flies. We will go to the pond in the field to-day, to look for some more insects which live in the water like the dragon-fly nymphs. We will let down a bottle into the pond on a string, pull it out again and hold it up to the light. Do you see what a number of little white and red egg-shaped creatures we have caught? They are called water-fleas,[1] and are small relations of crabs and shrimps, so are not insects. A water-flea is a very interesting creature to look at through a microscope, in which you can see its tiny heart, its mouth shaped like a beak, with jaws, and the little cells or windows in its eye; and you can even watch its food being taken in and digested. It has five pairs of limbs inside its shell; the three pair at the back have sort of comb-like plates, which keep on shaking and quivering, and probably help its breathing. Even without a lens, you will be able to make out the two pair of antennæ—horns, or feelers—on its head, which look rather like claws, and are always moving or whizzing round; one pair is much larger than the other, forked at the end, and is covered with long hairs which help it in swimming. Perhaps too you will be able to see the eggs which the mother water-flea carries about under her shelly covering. Sometimes quantities of these little animals will crowd together, and pass round the pond like a shoal of fish.

CYCLOPS.—There is another queer little creature

[1] Daphnia pulex.

in our bottle, rather like a water-flea; she is called cyclops, and is carrying her two sacks of eggs, one on each side of her body. Some kinds of cyclops live in the sea, and shine like glow-worms, making the water look quite fiery. They are called cyclops from having only one eye, like the fabled giant who was said to have one eye in the middle of his forehead.

GNAT LARVÆ AND PUPÆ.—We have fished out, as I expected, a great many "pollywogs," as they are sometimes called, the larvæ and pupæ of gnats—gnat babies. You know that the mother gnat, like the dragon-fly, lays her eggs in the water; the eggs are massed together in the shape of a tiny floating boat. Can you tell me which is the head and which the tail of this queer gnat larva? Well, it swims head downwards, and the tiny tail at the other end of its body is the end of its breathing tube through which it takes in air from the surface of the water. It has two feelers (antennæ) in its head.

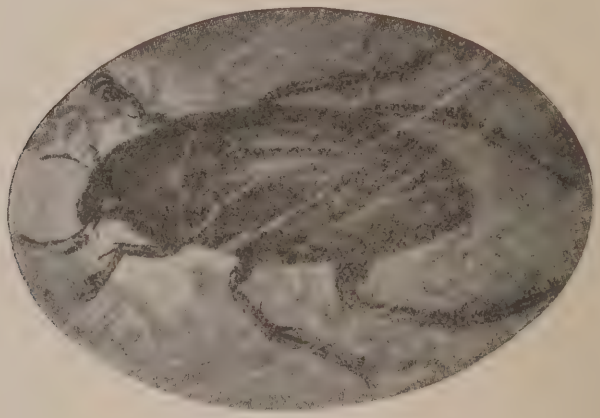
Here is another gnat baby, rather older; this is a pupa, thicker and more stumpy than the larva; it swims head upwards, for it has breathing organs on the upper part of the body; and it takes no food. After a time, the skin of the pupa splits, and the gnat comes out, standing upright at first in its old skin like a man in a boat. Perhaps fortunately, the gnats often get upset into the water, especially on a windy day, and are drowned, for of course the full-grown gnat cannot swim as its larva and pupa can.

WATER-BEETLES.—Let down the bottle again and see if we shall find something more. Ah, here is the larva of the great-water-beetle.[1] He is a most greedy beast, both as larva and full-grown beetle. Do not put him in with any other creatures in a bucket if you want to keep them alive and watch their habits,

[1] Dytiscus marginalis.

for he would eat them all up. A friend of mine put a great-water-beetle larva in a bowl with some tadpoles, not knowing this, and when she looked for them soon afterwards she found that he had devoured them all! The beetles also attack and eat each other if kept together.

You will notice that this larva has a long bending tail with which it swims, ending in two pieces rather like leaves. Its breathing holes are set all along the sides of the tail. It has a big head with arched jaws,



GREAT-WATER-BEETLE.

and these jaws are pierced, so that probably it can suck the juices of its victims. This particular larva seems full grown, so it will soon bury itself in a hole in the bank and change into a pupa, and there it will stay for about a fortnight or three weeks before turning into a "perfect" beetle; if it were later in the autumn the larva would remain buried there all through winter.

The beetle into which it will change is also a curious creature. Here is one swimming about in the pond, broad, egg-shaped, blackish olive coloured. Notice his back legs which are like paddles for rowing himself about, strong and broad, and furnished with stiff hairs. He lives partly on land, partly in the water; if one pool

dries up he has only to spread his wings and fly off to another. Sometimes he will come down "flop" on a sheet of glass, such as the top of a greenhouse, mistaking it for water! Like most winged water insects he flies chiefly at night.

You notice that every now and then he stops rowing, and then being light, he rises at once to the surface, tail uppermost. This is because his breathing holes are placed just under his top wings, which are hollowed out, and will hold a certain amount of air; but as soon as the supply is used up, he comes up to the surface of the water to get some more. It is said that water-beetles may live five years. Sometimes we may see them in winter swimming about under the ice.

WHIRLIGIG-BEETLES.—Over there I saw some near relations of the great-water-beetles, the little whirligig beetles,[1] skimming and whirling round on the top of the pond. It would be very difficult to catch them, and I do not think we will try, for if caught they squirt out a milky fluid with a strong, disagreeable smell. Each of their two eyes is divided into two parts, one half looking upwards and the other downwards, and no doubt this makes them able to see their enemies coming, either the birds from the air above or fish, etc., from the water below. They use their front feet as rudders and their middle and back pairs as oars. The mother beetle lays her eggs on the leaves of water plants, and the long white larvæ can jump; when they are going to change into pupæ they leave the water for the leaves of water plants, where they spin themselves cocoons.

WATER-MEASURERS.—We see some black water-measurers[2] gliding slowly along the top of the water, very thin and slender, and very quiet-looking, but terrible to the smaller insects on which they feed! If you can manage to look at them sufficiently near, you will find

[1] Gyrinus natator. [2] Hydrometra stagnorum.

that their middle and back legs are very long for carrying them over the water, and are stretched out broadways, but their front legs are directed forwards, and are like hands for seizing and holding their prey, which they suck with their long beaks.

GERRIS AND OTHER HEMIPTERA.—And here are more members of the water-bug family, the little gerris which swim over the water, wheeling and turning like clever skaters; their body, as you see, rather like a wherry in shape. Another relation is that water-boatman [1] which you see there floating on its back and rowing itself along with its flattened hind legs. And here comes a queer-looking brown water-scorpion,[2] who is very fond of burrowing in the mud; he gets his name from his great front legs, which are rather like a scorpion's pincers, and they move in the same way when he seizes his prey. When he is not using the two last joints of those front legs, he folds them up and puts them away into a groove in his thigh, just as you shut up your pocket-knife fitting the blade into the handle. Like the rest of the bug family, he has his mouth fitted into a sucking beak.

THE GIFT OF LIFE.—Strange to think that were we to kill the tiniest of the tiny creatures with which every drop of this pond water is swarming we could not give it back God's wonderful gift of life. Of these millions of little beings we may say, "These wait all upon Thee, and Thou givest them their meat in due season. Thou openest Thine Hand, and fillest all things living with plenteousness!"

[1] Notonecta glauca. [2] Nepa ranatra.

Questions

1. What do you see if you look at a water-flea through a microscope?
2. What do the female cyclops carry about with them?
3. In what shape does a gnat lay her eggs?
4. How can you tell a gnat larva from the pupa?
5. What does a great-water-beetle larva do with its tail?
6. How does the great-water-beetle row itself, and how does it breathe?
7. Describe a whirligig-beetle.
8. Why are the water-measurer's middle and back legs stretched out broadways and the front legs forwards?
9. Name some other water-bugs.

SEPTEMBER 1

Buried to Live

A WHEAT FIELD.—There is a field of very useful grasses which we will go and look at to-day; men are there hard at work; you know what I mean? a wheat field. They are gathering in the "fruit" of those grasses, and from that fruit our bread is made.

A GRAIN OF CORN.—I daresay they will let us take a blade of the corn, and we will examine one of the ears closely. Here is the baby wheat plant—that

little piece on one side at the bottom. Cut the grain open and you will find it full of the white starchy stuff which feeds and nourishes the young plant. The grain has two little coats or "tunics"; the outside coat has a little fringe of hairs at the top; the inside coat sticks so fast to the seed that it can only be parted from it in

Cutting Corn.

the grinding. It has a little seed leaf called a "cotyledon."

GROWTH OF THE NEW PLANT.—Now if we take one of these grains and plant it in moist earth, what will happen? As the baby plant grows, the bud of the stem, called the plumule, will begin to shoot upwards, and the little sharp radicle, or root bud, will begin to push downwards. Both the plumule and radicle will have a little covering or sheath over its top part. Then the radicle will be sending out under the ground several more rootlets, or tiny roots, each sheathed like itself, and each of these young roots will

become covered with thick white hairs: the hairs will suck up food out of the ground. And then these will in their turn send out secondary roots. So by degrees the new wheat plant will grow, and have fresh spikelets in its turn; "first the blade, then the ear, after that the full corn in the ear."

STARCH AND GLUTEN.—The white part inside the grain, which is around the baby plant, is quite full of tiny grains of starch and gluten, which you could only make out with a strong lens. Gluten is the sticky stuff which you feel in your mouth after chewing a grain of corn. This starch and gluten feed the baby plant, and make the flour of the bread nourishing. It also holds a certain quantity of gum and oil.

WHEAT FLOUR.—Of course the chief use of wheat flour is for making bread. It is also used as starch in laundry work, and, like the starch of potato, for making British gum. Maccaroni, vermicelli, semolina, etc., are all made of wheat flour. And the straw of wheat and other corn is very valuable.

DISTRIBUTION OF WHEAT. — Wheat likes a temperate climate best, neither too hot nor too cold. As you know, a very great quantity is grown in America.

Wheat is mentioned in the Bible, in the Old Testament as well as the New, and in the works of old Greek and Roman writers, and it has been found in the coffins of Egyptian mummies; but no one knows how long ago it was first cultivated, or where it was first grown. Some think that probably it was cultivated from certain grasses,[1] which are now common in South Europe.

ALLIED GRASSES.—Several grasses belong to the wheat family; this couch grass growing by the road

[1] Ægilops.

side, this bearded wheat grass which cattle enjoy so much, are its brothers ; and also the kind called crested wheat grass, which is very rare in Britain, but common in some other parts of Europe.

The hard wheats make rather better flour than the soft ones, as the grain contains more gluten. Bearded wheat is protected from birds by its long awns.

DISEASES OF WHEAT.—Wheat has many diseases. There are several different sorts of fungi which attack it. Bunt or black ball is one, a sort of dust fungus, which often seizes on the young plant before the spike has come out from its sheath, and sometimes also appears on the stem. A long time ago some corn seeds which had been saved from a wreck were planted, and it was noticed that the corn which came from these seeds which had been in salt water was free from bunt; and thus the plan of "dressing" seed with salt was discovered. In these days it is treated with bluestone and water to prevent bunt and smut.

Another fungus which spoils wheat is mildew, showing itself in little dark dots and lines on the stems and leaves. We shall probably see some wheat blackened with it, for not many fields are quite free from it. And another is rust, often called red gum, red rag or red robin, which covers the leaves, and sometimes even the spikelets, with orange spots.

HARMFUL INSECTS.—Then there are the very troublesome little eelworms, called earcockles, which make the galls called "purples" or "false ergots" in the ears of wheat, often quite ruining it. Vast numbers of these worms may be found in one cocklegall.

Also the grubs of the click, or skipjack, beetles, called wireworms, are very harmful, for they gnaw the roots and underground shoots of the crops. The wireworms are tough, smooth, shining, rather flat grubs, yellow coloured. Rooks, starlings, and other birds,

especially plovers, are very useful in keeping them down.

The larvæ (maggots) of various flies also feed upon wheat plants. The striped wheat-fly which lays its eggs in June on the spikes which are just coming out; the grub called red maggot which is the larva of the wheat midge, a kind of gnat; and the ribbon-footed corn-fly, a near relation of the dreaded Hessian-fly of America, which attacks the heads of the corn, causing them to swell and decay (this disease goes by the name of "gout") are all great enemies to wheat.

LESSONS FROM WHEAT. — The Bible often speaks of corn, and gives us many lessons from the harvest field. Our Lord once said about Himself, "Except a grain of wheat fall into the earth and die, it abideth by itself alone; but if it die, it beareth much fruit," [1] thus showing that as the grain must be buried in the earth, and all of it, except the tiny beginning of the plant which is in it, must die away before the new plant springs forth; so He must die and save the world by His death and resurrection, and raise the souls of men to a new life in Him.

FLOWER OF GRASS.—We have studied the "fruit" of wheat grass. And now I want you to look at one of these grasses by the wayside, and get to know its flower.

Take this wild oat; look at its little spikes—or glumes as they are called. Some are empty, but some are called "flowering glumes." These flowering glumes have in them three stamens and a pistil. The stamens, as is usually the case in grasses, are very slender and delicate, and the anthers at the top, holding the pollen, hang on loosely. In grasses the pollen is carried about by the wind, not by insects; so you see it is a good thing that the anthers are loose and easily shaken.

[1] St John xii. 24.

POLLEN.—In some grasses, such as the Timothy grass or cat's-tail, you can see the stamens standing out on the outside of the grass, ready to scatter their pollen; and you may see them on the outside of the wheat spikelets. The pistil, in all grasses, has only one cell at the bottom, holding the one little ovule which is to turn into the seed or grain when it has been touched by the pollen.

AWNS.—Many grasses, such as our wild oat and bearded wheat, have long sort of hairs at the tips of their glumes; these are called awns.

COLOUR.—You will notice that as grasses do not need to entice insects, they are generally green or dull coloured, instead of being bright and showy.

STEM.—If you cut open the stem of a grass, you generally find it is just a hollow tube. That hard gritty feel which you find in grasses if you draw them through your hand, comes from a coating of a flinty substance called silex, and there is flint in all the joints.

SUGAR.—Many grasses have sugar in them, and those which have thick leaves, and ears close together, are generally the most sugary; those with spreading ears and flat rough leaves are often more salt. If you pick almost any meadow grass in the springtime and draw the young stalk gently out of the sheath and chew it, you will find it quite sweet. The sugar cane is a grass.

FODDER.—Of course grasses which are fodder for cattle are of great importance. Sheep, horses and cows have strong likes and dislikes in their food. This common holcus is full of sugar and therefore cattle do not seem to care for it much. This rye grass, Timothy grass, fescue, sweet vernal grass, and crested dog's-tail, are among the most valuable fodder grasses. The thin

stems of crested dog's-tail are also very useful in making hats and bonnets.

NUMBER.—Almost all grasses are wholesome and useful; you know how they "come creeping, creeping everywhere." A botanist found fifty-six different kinds on the ruins of the Colosseum at Rome.

Questions

1. How is the baby plant nourished in the grain of wheat?
2. What makes wheat flour nourishing?
3. Name some grasses which belong to the wheat family.
4. What different sorts of fungi attack wheat?
5. Name some insects which are enemies to wheat.
6. How is the pollen of grasses carried about?
7. What are the long hairs called which we see on the tips of the glumes of bearded wheat?
8. How can you generally tell the sugary grasses from the kinds which are salt?
9. Name some of the most valuable grasses used as fodder.

SEPTEMBER 15

The Humblest Members of the Vegetable Tribe

EDIBLE FUNGI.—We will go fungi-hunting this morning. Like mosses, fungi may be looked down upon or overlooked by some people, but they are often pretty, often curious, and always more or less interesting. I know a lady who made a very pretty decoration for

her dinner-table of red toadstools arranged among fir branches. We all know that many fungi are poisonous; but there are a great many which, like the field mushroom, are good to eat; though of course it would be very dangerous to try eating toadstools, without advice from someone who knows well which are poison and which harmless! As a rule, the wholesome fungi are of dark, sober colours. An old Latin poet[1] says,

> "The meadow mushrooms are in kind the best,
> It is ill trusting any of the rest."

AGARICS.—The mushroom which is most often eaten, the "edible" or "meadow" mushroom, belongs

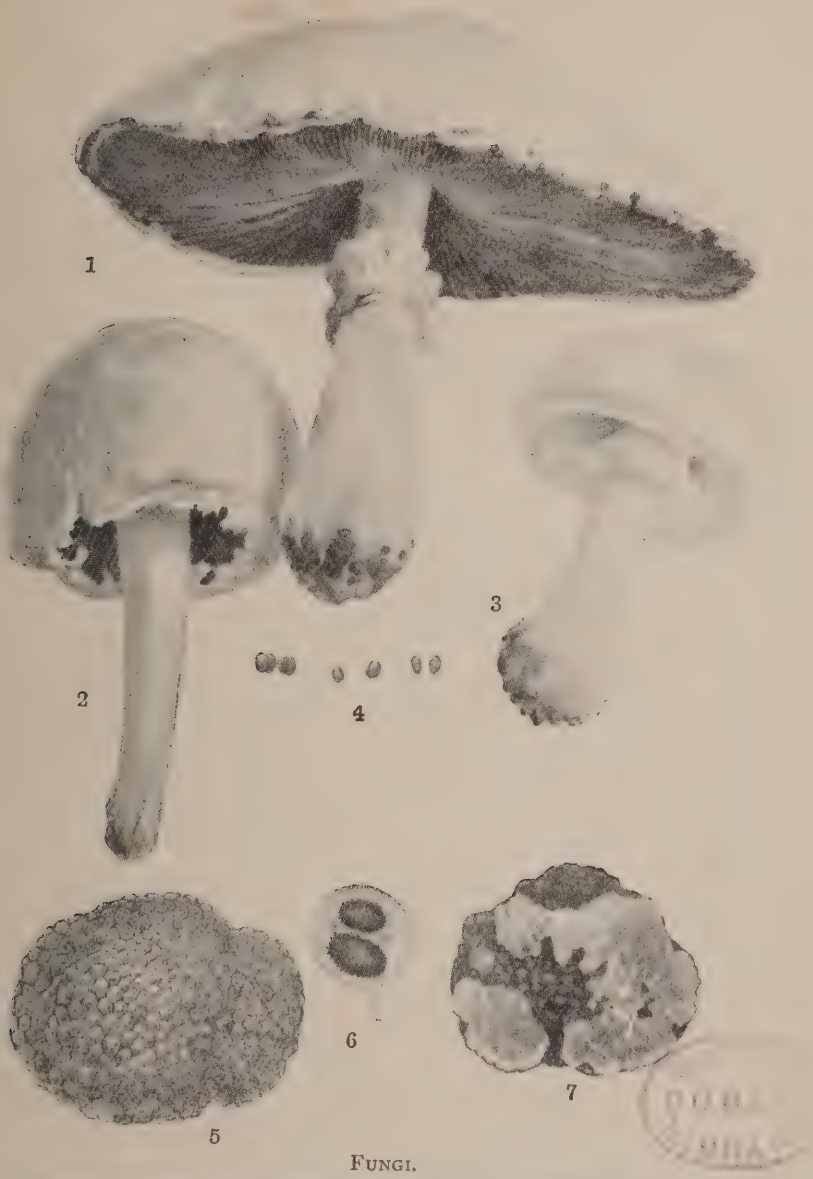
FUNGI.

Agaricus campestris (Mushroom). *Tuber melanosporum* (Black Truffle).

to a very large family called agarics. They are of all sizes, and many different colours. Horse mushrooms, as you know, may grow to an immense size; one has been written about which measured 4 feet across and weighed 2 lb. 14 oz. But there is another kind of agaric,[2] like a tiny cap on the top of a stem, which seldom grows to more than $\frac{1}{2}$ inch high, and you could destroy it with a breath; you would want 72 thousand specimens of this fungus to weigh an ounce, and yet each tiny specimen is made up of more than 25 million cells!

SPORES.—On yonder stump I see one of the agarics[3] which grows all through the winter; it is yellowish in colour, and its stem is covered with a very

[1] Horace. [2] Coprinus radiatus. [3] Agaricus velutipes.



FUNGI.

1 and 2. *Agaricus campestris*, Common Mushroom (var. *psalliota*), in different stages of growth.
3. ,, ,, var. *amanita*.
4. ,, ,, Spores.
5. *Tuber melanosporum*, French Truffle.
6. ,, ,, ,, ,, Spores.
7 ,, ,, ,, ,, cut through middle

dark velvety down, which sometimes shines in the dark. Here, in the wood, is a very pretty scarlet fly agaric, or fly bane; it is poisonous in Britain, but in some countries it does not poison, though it intoxicates, and oddly enough it is eaten in Kamtchatka. You might pick it, and I will tell you how you may see its spores or seeds. Cut off its cap from the stem and lay the cap on a sheet of paper. After some hours lift it up, and you will see thousands of spores lying in a regular pattern on the paper, marking where each of the "gills" or folds of the inside of the fungus lay, for these folds held the seed. With a pocket lens you can see the spores as little black specks at the end of the white club-shaped cells.

LIFE OF FUNGI.—Fungi, as a rule, grow very quickly; thus a fungus has been called—

> . . . "The sudden curious stool
> That perfects in a night."[1]

The beef-steak fungus, which grows on the trunks of oaks, and is the only British species of the fistulina[2] family, will sometimes grow so large that it weighs nearly 30 lb., and yet will get to its full growth in a fortnight, perishing again in three weeks' time.

But other fungi, like this birch lenzites, which is common on old stumps and rails, will last so long that at last it becomes almost like a piece of the old board on which it grows.

PUFF BALLS.—Puff balls belong to the envelope fungi, for the fruit-bearing part is enclosed in a case or envelope.

HARMFUL FUNGI.—We cannot really overlook fungi, even if we try, for they are always with us! Often very mischievous; there are fungi which cause diseases amongst human beings; and the smut, bunt and mould which bring disease to our cornfields and gardens, and

[1] Christina Rossetti. [2] Fistulina hepatica.

the dry rot which sometimes attacks our buildings, are all fungi. Useful too; the good yeast in our bread is a fungus. And some of our greatest forest trees, oaks, beech, etc., and also the sturdy heather, depend partly for their food on the cobweb-like spawn of fungi.

SYMBIOSIS.—For these spawn threads live on the tips of their roots, and are like channels or mouths helping to draw out moisture and food from the soil for the tree. And the spawn threads in their turn feed themselves on what they find in the roots. Truffles help pine-trees in this way. Also they cause the vegetable remains in the soil to decay more quickly, and so the trees' roots can suck them in the sooner. In return the tree keeps the fungus and feeds it, and so the big plant and the little help each other. The first Scotch emigrants to Canada took heather with them and planted it, but the heather soon died; they did not know the real reason, which was that its fungus feeders in the Scotch peat mould had not been taken along with it!

THREAD FUNGI.—The moulds belong to the thread fungi. The "vinegar plant,"[1] which I daresay you have often seen on vinegar made from wine or beer, is a thread fungus.

Some fungi must often escape notice by looking so much like their surroundings. Perhaps you can find some? There is a yellow agaric which looks just like a faded leaf lying on the grass. Some dark fungi which live on charcoal or charred ground are like the blackened soil. There are agarics which flourish among dead pine leaves and look like pine cones; and others which grow on rotten wood, dead bracken, dead leaves and twigs, and sawdust, might easily be mistaken for the things they grow on. A fungus which lives among snow on high mountains is snowy white.

[1] Mycoderma aceti.

SLIME FUNGI.—You might not think that there is anything much to learn from the dark brown stain on this wall, but it belongs to a very interesting family! it is one of the myxomycetes or slime fungi. Some of the slime fungi are very common. They are like little spots or stains on dead stumps, fallen leaves, etc., often black or dark tinted, sometimes white, yellow, crimson, or violet. They are interesting because they seem to be half animal and half vegetable; they are a little like one of the lowest forms of animal life, the amœba, and also seem related to fungi, and like fungi they have spores. These queer things crawl slowly and spread themselves over the walls, leaves, etc., on which they live. The "flowers of tan" on sawdust, and the "finger and toe disease" of turnips, are slime fungi.

LICHENS.—We have not left ourselves much time this morning to hunt for lichens, but we can find them everywhere, as you know, and at all times of the year. Some botanists think that they are relations both of the fungi, and of the algæ to which family seaweeds belong. They are useful in dyeing and in medicine. I think some of the prettiest are these cup lichens, or cup mosses as they are called, with their tiny cups or goblets, growing out of a green crust.

TRUST.—A poet has found us a lesson of faith and trust in God even from the humble little lichen :—

"Knowing each germ of life He gives
Must have in Him its source and rise;
Being that of His being lives
May change, but never dies.

Ye dead leaves dropping soft and slow,
Ye mosses green and lichens fair,
Go to your graves, as I will go,
For God is also there."

Questions

1. Of what sort of colours are the edible fungi generally?
2. To what family does the meadow mushroom belong?
3. What part of a fungus holds the spores?
4. How long may a beef-steak fungus live, and a birch lenzites?
5. To what kind of fungi do the puff balls belong?
6. Name some mischievous fungi.
7. How do the spawn threads of fungi help some trees to grow?
8. Why did the heather die which was taken by the first Scotch emigrants to Canada?
9. Name some instances of fungi escaping notice by looking like their surroundings.
10. What do slime fungi look like?
11. How are some lichens useful?

OCTOBER 1

Flames of Fire

ELECTRIC LIGHTS.—We will have our talk indoors to-day for a change, and it shall be about a thunder-storm.

You have all seen lightning, I daresay you have all seen electric light in streets or buildings, and you may have noticed a cat's fur giving out sparks if it is stroked in the dark? Now all these bright lights come from the same cause—from electricity—that strange

force in Nature which even now the wise men of science do not quite understand.

LIGHTNING.—There is always electricity in the air, not only in stormy weather. There is a great deal about on a foggy day. And lightning may be caused by the electricity in a thundercloud meeting an opposite electric charge in the earth, when the two electric currents join and let off a spark, cleaving the air with great force and sound. Or it may be caused by two clouds meeting each other, charged with two different kinds of electricity, when the electricity jumps from one cloud to another, splitting the air which rushes together again with a loud noise.

ELECTRICITY IN CLOUDS.—We know that there is electricity in the clouds. You have seen large masses of clouds, often miles thick, which appear when a great thunderstorm is going on, and how torrents of rain fall from them in big drops, often with hail also? Certainly drops of rain are electric, for sometimes they give out tiny sparks when they come near the earth, and sparks have been seen given out from an open umbrella in a snow shower.

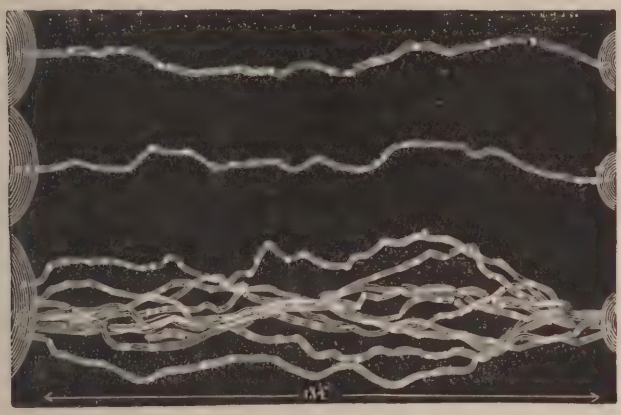
THUNDER.—And what causes the thunder? The lightning tears and disturbs the air and sets the waves of sound moving, and this makes the noise which we call a thunderclap; for sound is caused by waves of air just as light is caused by waves in the ether.[1]

But sound travels much more slowly than light—1100 feet a second—and so you do not hear the thunder at the same moment that you see the light; often many seconds pass after you have seen the flash before you hear the clap.

Sound, too, does not travel so far as light. It is said that lightning may be seen at a distance of 150 miles, but that thunder could not be heard beyond 27 miles.

[1] *See* the lesson on "Light."

VARIETIES OF LIGHTNING.—There are different kinds of lightning. The most common is called the sinuous, which bends from side to side. Then there is is the ramified which gives off branches from the middle streak as the branches shoot out from the stem of a tree. The meandering lightning forms small loops. There are great flashes which light up the whole of the thunder cloud. And there is the heat, sheet or summer



SLOW LIGHTNING.

lightning which generally belongs to a storm at a great distance, too far away for the thunder to be heard.

COLOURS OF LIGHTNING.—In the lower regions of the sky lightning is generally white, but higher it is often violet tinted.

LIGHTNING CONDUCTORS.—The lightning caused by the meeting of two clouds is not dangerous; the dangerous lightning is that which meets the electric current from the earth and runs down the nearest object which is in its way. It generally strikes from above, but sometimes it goes up. Trees draw lightning by their sap, which the heat changes into steam, and then the steam may burst and shatter the tree. It is

not safe to stand under a tree in a thunderstorm, for the lightning may leave the tree and strike the person standing under it.

EFFECTS OF LIGHTNING.—If lightning passes through the ground it melts the hard silica or flint in the earth and often forms those curious tubes called fulgurites, looking as if they were made of glass. It also brings a gas called ozone out of the air, causing a peculiar smell. Also it forms nitric acid, which is found in large quantities in the rain water falling during a thunderstorm.

FIREBALLS.—Have you ever seen a fireball? It is a very mysterious visitor, and no one knows whence it comes or how it is made. It seems to fall from a thundercloud, and is generally shaped like a globe, but I have seen one of a pear shape; sometimes it rebounds like a ball, and bursts with a lightning flash and a loud noise.

AURORA.—An aurora borealis is not very often seen in Great Britain, but it is common in the far North and in the Polar Regions, where it is called, "The Northern Daybreak" or "Northern Lights." It is like a great arch in the sky, with quivering streaks or streamers shooting upwards, red, crimson, white, etc., which have been given the name of "merry dancers." It is thought to be caused by electricity.

USES OF ELECTRICITY.—Electricity is becoming more and more the servant of man; strange and mysterious as it is, and little as one might expect to be able to capture and use that of which lightning is made! It is employed, as you know, in telegraphy, railways, lighting, medicine, surgery, and in many different kinds of machinery, while clever people never cease finding out fresh ways of turning it to account.

THE THUNDERSTORM PSALM.—I think one of the grandest Nature Psalms is the twenty-ninth, which describes a thunderstorm :—

> "The God of glory thundereth,
> The voice of the Lord cleaveth the flames of fire.
> The voice of the Lord shaketh the wilderness ;
> And in His Temple everything saith Glory."

And it ends by telling how His people need not fear, for the God of the mightiest forces in Nature shall give them strength and peace.

Questions

1. What different kinds of light are caused by electricity?
2. In what different ways may lightning be brought about?
3. How is thunder caused?
4. Why may you see the lightning flash before you hear the thunder?
5. Name some different kinds of lightning.
6. Why is it unsafe to stand under a tree in a thunderstorm?
7. What are fulgurites?
8. Name some uses of electricity.

OCTOBER 15

Builders of Silken Tents

HOW SPIDERS DIFFER FROM INSECTS.—When we were studying dragon-flies we found out something about insects in general. Most of them pass through three stages in their lives (larva or grub, pupa or chrysalis, and perfect insect); every insect has three separate parts or divisions in its body—head, chest, and "tail" or abdomen; and it has always six legs.

Many people speak of spiders as insects, but this is a mistake. Do you notice any differences between a spider and an insect? A spider has eight legs, not six; its head and chest are joined into one piece without any neck or division; and it does not go through any change of form in its life history, though it moults its skin at least four times. The house spider moults nine times. Some kinds seem able to grow a fresh limb if they have lost or maimed one.

SPIDERS' MOUTHS.—It is altogether very interesting to study the way a spider is made. You will notice that in every respect it is formed to be "a beast of prey"! Spiders have two pairs of mouth-parts for seizing and devouring their prey. One pair is supplied with poison-glands at the base, for sending poison into the insects on which they feed. The other pair looks rather like an extra pair of legs. The jaws or "piercer claws" are specially large in scorpions.

EYES.—A spider is well furnished with eyes. Many spiders have eight, some have twelve. The eyes are placed on a kind of pillar behind the head. Some-

times one pair is very large indeed and placed, like carriage lamps, in front of the head. But there are little spiders found under leaves in Ceylon which are quite blind.

WEBS.—And of course you know the wonderful webs which many spiders make for trapping their food; but have you ever watched one spinning? Here is a common garden or wheel-web spider, also called the cross spider because it has a triple yellow cross on the dark brown band which runs along the middle line of its green body. We know well the shape of its great web which is like a wheel, but let us try to see how the spider makes it. I must tell you that she has inside her many small glands full of a sort of sticky fluid, and there are little passages leading from these glands to the spinners at the end of her body. Now here she is sitting on the leaf of a tree. She opens her four spinnerets, and lets out a long, long thread made of that sticky stuff I mentioned. This thread is made up of about 4000 strands, so thin that it is said if a million were twisted together they would make a rope little thicker than a hair of your head, and yet so strong that they would bear a weight of three grains.

You may see how strong the threads are, if you notice sometimes after rain the webs in the grass, looking like little pockets or purses full of great round drops of water which weigh them down but cannot break them.

Well, our spider lets the wind blow this thread over to the opposite bough, and now she runs across it and fastens it tight to the bough; then she drops to a lower twig, and lets out a fresh line, which she carries back to her starting point and makes all firm. These lines form her scaffolding or foundation on which to build up the spokes of her wheel, and then the circular lines are glued upon them. Had the wind been blowing the wrong way for her, she would just have fastened the

threads around herself, and then swung backwards and forwards till she had hit against a good support.

The first suspension bridge has been described as "an engineering feat of which the spider was the earliest discoverer!"

When she has spun and tightened the spiral threads, they are covered with tiny drops which remain sticky all day; but the lines which make the spokes of the wheel become dry at once in the air.

CLAWS.—True spiders have two or three bent claws on their toes to help them to cross their webs and to tighten them. If you could look at our garden spider's fourth pair of legs through a lens, you would see the third claws upon them very much bent, for drawing the threads tight. And she has a sort of "comb," or collection of bristles for "teasing" or carding a peculiar kind of silk from her fourth pair of spinners (as a weaver might curl it), for scattering over her lines to catch her prey more easily.

CAPTURE OF PREY. — She takes about three-quarters of an hour to spin her web, and uses about twenty-five yards of thread. When she is sitting head downwards in her web, and feels by a shaking along the line that a fly is caught, she seizes him, packs him neatly into a little silk case of her own making, and carries him into her larder.

Some spiders, such as the house spider, spin webs slung across from one corner of the room, or one leaf, to another, like hammocks.

JUMPING SPIDER.—The pretty zebra or jumping spider, which has silvery stripes on its brown body, does not spin a web, but tracks its fly down and jumps upon it. Wherever it goes it fastens a thread behind it, and this thread sometimes trips up the unsuspecting fly, acting like the wires placed by burglars around a house they intend to rob.

GOSSAMER SPIDERS.—The gossamer threads which sometimes brush against our faces on a fine still day, are thrown out by the tiny gossamer spiders, which are no larger than a pin's head. These threads support them in the air like a balloon, and sink to the ground when weighed down by moisture.

NESTS.—Spiders spin silken nests for their eggs. You may find a little spider's nest in this rolled-up leaf, and here is one in the middle of these few blades of grass tied together. If you take away a spider's nest she will hunt for it anxiously.

WATER-SPIDERS.—The water-spider makes a very curious nest in the water, shaped like a bell or a wine-glass turned upside down. It is formed of threads spun on to the stems or leaves of water plants, and filled with bubbles of air which she carries down from the surface entangled in her hair. Here she sits in her diving bell nest, spreads her web, and catches water mites and other prey.

FOOD.—Spiders are great eaters and drinkers. A spider has been known to eat twenty-six times its own weight of food in a day.

THREADS.—Ladies in Bermuda use spiders' threads for sewing; and a Frenchman once made a pair of gloves and a pair of stockings of spiders' threads, almost as strong as ordinary silk, and of a grey colour. People have sometimes considered whether spiders could be made as useful as silkworms. But it seems impossible to keep a number alive, as they are very quarrelsome together and are great cannibals.

You may have noticed their curious way of shamming death if you come near them? They roll themselves up and fall to the ground as if dead.

STUDYING SPIDERS.—If instead of running away (like the child in the nursery rhyme) when we see a

spider, we try to study him, we shall find out how interesting he is, and learn again the old and ever new lesson that "in little things God is great."

Questions

1. What are the differences between a spider and an insect?
2. How are spiders fitted for preying upon insects?
3. How can you see the strength of the threads in a spider's web?
4. What is the use of the bent claws on the spider's foot?
5. Where do the house spiders spin their webs?
6. How does the jumping spider catch its prey?
7. What are the gossamer spiders like?
8. What kind of nests do spiders make?
9. What is the water-spider's nest like?
10. Is spider's silk of any use?

NOVEMBER 1

The Kings of the Forest

THE OAK.—Last September we were thinking about some of the humblest and smallest members of the vegetable world. To-day we are going to study one of the proudest and largest, the oak tree, which has been called the king of the woods.

ITS FLOWER AND FRUIT.—We have often thought about the flowers and fruits of different sorts

A Patriarch of the Woods.

of plants. The oak tree has hanging catkins or spikes, with from five to twelve stamens, and its pollen is scattered by the wind. Its fruits you must know, for they are the acorns which lie about the roads in the autumn.

THE CATKIN FAMILY.—We know these British oaks well, with their prettily shaped leaves; the leaves often hang on the branches throughout the greater part of the winter, though they fade and turn yellow; and probably they help to protect the young buds. The oak belongs to the catkin family, to which belong also the alder, birch, hornbeam, hazel, beech, willow, and poplar. How many of those trees can you show me?

VARIETIES.—British oaks are of two chief kinds; the pedunculated or white oak, which has leaves with no stalks or very short ones; and the sessile-flowered or red oak, with leaves on stalks from half an inch to an inch long, and leaves of a less deep green. But though they are called British oaks they grow in many other parts of Europe too. We often see other kinds in Great Britain, which are, however, introduced from other countries. Such are the ilex or evergreen oak, the cork tree, the turkey or moss-cupped, and the North American red oak.

OAKS IN ANCIENT HISTORY.—Oaks have always been famous. They are several times mentioned in the Old Testament, though sometimes terebinth trees seem to be meant. Acorns were eaten in Greece and Italy before the ploughing and sowing of corn was invented; and a famine of acorns would have been as serious as a famine of corn would be now. The word "oak" is thought to come from the Anglo-Saxon "aack" or "ak," and "acorn" from "ac-cern," oak-corn, as the Saxons would have probably eaten acorns when other food was scarce. The Greeks said that the oak was the first tree

created, and that the dryads or forest divinities lived in the oak woods; and when they wanted to swear a solemn oath they would say, "I speak to the oak."

DRUIDS.—You must have read in history books how the Druids, the priests of the ancient Britons, treated the oak as a sacred tree? They worshipped under the oak, and kept a fire of oak timber always burning in honour of a god who seems to have been something like the Roman Saturn, and once a year all the people lit their fires from this sacred flame. They had a great service when they looked for mistletoe on the oak trees; before they began they offered sacrifices in baskets made of oak twigs; and when they found mistletoe they cut it from the oak with a golden knife. So you see that the custom of burning the Yule log and hanging up mistletoe at Christmas has come down from those old heathen days!

SAXON OAK FORESTS.—The Saxons made laws about the fattening of pigs on acorns in woods, and in Domesday Book account is taken of the number of hogs each forest would fatten. There is a record of a man keeping "pannage" or acorn-feed of 200 pigs as part of his lady's dower.

BOG OAK.—Every now and then fossil oak timber is dug out of the ground, showing how very ancient are the oak forests. Thus, great black masses of fossil timber called bog oak are found in the peat in Ireland. A fossil oak was found in Yorkshire with the timber quite sound, though it was thought that it must have lain there above 1000 years, for coins of the Emperor Vespasian were dug up near it.

AGE OF OAKS.—An oak grows more slowly than any other British tree, and as you know, it will live to an immense age. Dryden says,—

"The monarch oak, the patriarch of the trees,
Shoots rising up, and spreads by slow degrees;
Three centuries he grows, and three he stays,
Supreme in state, and in three more decays."

FAMOUS OAKS.—At Winchester the famous round table called "King Arthur's Table" is made of oak planks and is 18 feet across. The cradle of Edward II. at Carnarvon Castle is made of oak. A house called Ashby Canons (belonging to the descendants of the poet Dryden) has a room 30 feet by 20, of which the floor and wainscoting were made of a single oak. Many years ago an oak fell in Sheffield Park, and two men on horseback on opposite sides of the fallen trunk could not see the crowns of each other's hats. A hollow oak, which was the favourite resting-place of a bull, could hold twenty people inside its trunk; a calf was shut up in it for convenience, and its mother went to it regularly to feed it.

There is a curious oak tree in Staffordshire of which the leaves, when they first appear, are yellow, becoming green later.

CULTIVATION.—King Henry VIII. made laws for planting and keeping oak timber. Some verses written in his time ran thus:—

"Sow acorns, ye owners that timber do love;
Sow hay and rye with them, the better to prove;
If cattle or coney may enter the crop,
Young oak is in danger of losing his top."

USES OF OAK.—Before pine and fir began to be brought into England, about the beginning of the eighteenth century, oak timber was used for almost everything. Of course it was most valuable for ship-building, especially before ironclads were invented. The buds of the oak, its leaves, acorns, galls, and more especially its bark, are used to produce tanning, em-

ployed so largely in manufacturing leather. The bark and galls are also used in medicine and in dyeing.

TIMBER.—The timber is hard, tough, very strong and lasting, not easily soaked through, and yet not too heavy. If you look at the shape of an oak tree you see how it is made for strength. And you see how the great branches (often bent like a giant's arms bending at the elbows), are suitable for shipbuilding. An oak has deep roots so that it is seldom blown down in a storm. Its massive trunk is needed to hold the great branches, which spread themselves out on all sides rather than grow upwards. You often find that the trunk is widest near the ground, narrower a little higher up, and then that it widens again near the part where the chief branches begin to grow. When Smeaton in 1759 had to rebuild the Eddystone Lighthouse, he went to an oak to learn how to build on a strong plan.

INJURIOUS INSECTS.—If we examine an oak we shall soon find the work of some of its many enemies, for it is attacked by a very large number of insects. A curious account is given in old books of some cockchafers which are said to have appeared on oaks in County Galway in 1688. In the daytime they hung from the boughs in clusters like bees, and flew away at sunset. The noise they made in feeding on the leaves sounded like the distant sawing of timber. Though it was the middle of summer, the boughs were left as bare as if it had been winter. Pigs and poultry fed and became fat on the unwelcome insects.

GALLS.—We shall probably find galls caused by different mischievous gall-flies, of which some are real flies and some belong to the wasp and bee family. These oak spangles are very common on the under part of the leaves. The oak apples are the largest kind of gall. The artichoke gall is like a little cone formed in the bud. Then there are marble galls, cherry, red-

streaked, small warty, flat warty, black shot, leaf twisted, root, currant, and pear galls. Some galls are used in making ink, and a great quantity of Aleppo galls are imported into England for that purpose.

It is thought that the "Dead Sea apples," described by old writers as beautiful to look at, but crumbling to dust, and bitter to the taste, were probably gall nuts.

Many kinds of insects attack oak timber. A great quantity of different lichens, mosses and fungi grow on oak trees.

BARNACLES.—The barnacle mussels cling to the oak timber of ships, sometimes even hindering their speed. There was a quaint old fable that barnacle geese came out of shells on oak trees!

GREAT AND SMALL.—This acorn is a tiny little thing, is it not, if we compare it with the great, strong, beautiful, useful tree which grows out of it? and so we learn that great things may grow out of small. Little good habits, thoughts, words and deeds build up a good, strong, beautiful and useful character, so that we may be "called trees of righteousness, the planting of the Lord; that He may be glorified."

Questions

1. What kind of flower and fruit has an oak tree?
2. Name some other members of the catkin family.
3. What varieties are there of British and foreign oaks?
4. What is the word acorn thought to come from?
5. What ancient people treated the oak as a sacred tree?
6. What is bog oak?
7. What parts of an oak are used in the manufacture of leather?
8. Describe the build of an oak tree.
9. How are oak galls produced?

NOVEMBER 15

The Builders of the Earth

THE HISTORY OF A STONE.—Just now I noticed some little children having a fine game by the roadside. They had built a little castle of heaped-up stones, with a little drawbridge over a tiny stream of water, and there were some blades of grass stuck into a heap of mud in front of the toy castle, meant as a flower garden.

If these stones could have talked, they might have had some wonderful stories to tell me about themselves! Do you know that every little common stone you see in the road has a long and interesting history, dating back through hundreds—or it may be thousands—of years? Let us think about this.

THE CRUST OF THE EARTH.—In the story of "Alice through the Looking-Glass," the pudding at the supper is made to get up on its plate and speak to Alice! Now if at supper time an apple tart could talk, and you asked the crust, "What are you made of?" it might answer "Of several things—sugar, flour, water." But the crust is not all. "I'll cut the crust," you say, "and see what is inside." You cut the crust, and steam comes out. What does that show? That there is heat inside the dish. And then, when we look at the hot mass of apple inside, we find that it is much thicker than the thin paste of the crust.

Now the "crust" of the earth—the outside part, some of which you can see—is made up of many different things. As a house is built up of stones and bricks, as the pie-crust is built up, so to speak, of flour and water, so the outside crust of the earth is built up

of stones, rocks and earths of different kinds, and each little stone which you see in the road might say, "I am one of the earth's builders," because it is just a chip off one of the rocks; as a tiny crumb of flour or sugar might say, "I am a bit of what makes the pie-crust." The mud in the roads too is simply rock—the crust of the earth—ground down.

LIMESTONE.—Let us see how many different kinds of stones we can find if we walk along the high road to-day, and whether some of them can tell us their histories. Here is a bit of limestone. How did it begin its history? Why, at the bottom of the deep sea! Millions of tiny seashells sank down there to the bottom when the creatures within them died. Their life had formed these shells from the lime dissolved in the sea, and when they died, the decayed shells were slowly built up and cemented into a hard limestone, helped also perhaps by morsels of clay and sand, bits of pebbles, etc., brought down by streams and strewn over the shallower bottom near the land. At last there came a time when the sea bottom was raised, and our bit of limestone became part of a limestone rock on dry ground. In the course of ages the rock was worn down by frost, rain, snow, wind, damp, etc., which wore it away and knocked bits off it and crumbled parts of it into dust and mud, and our stone was broken off from its rock. Perhaps in the course of ages the rock may have crumbled away into dust in the place where we found our stone; or the stone may have been washed down here, long ages ago, by some river (just as a river now washes down stones and mud and rubbish), or by a glacier of ice. Often we may see markings on rocks and stones where they were scratched by ice long, long ago.

CEMENT.—We can find limestone in another form if we go and look at yonder stone wall. You see the stones are stuck together with cement, and this cement is made of limestone mixed with clay.

MARBLE.—In the market-place of the neighbouring town you have seen a marble statue? That marble is one very beautiful kind of limestone.

CHALK.—Another kind of "rock," which has a great deal to do with limestone, you know very well—the chalk used for writing on the blackboard at school; and chalk is also made up of the remains of animals. Limestone is a very good and hard stone for building. It is also useful in another way as quicklime.

VOLCANIC ROCK.—Some stones, such as pieces of granite, come from rocks which are thought to have been first formed by fire. How could fire form a rock? Well, you have heard of volcanoes, I daresay you have seen pictures of them, and you know that they are like great basins of fire in certain mountains, which sometimes break out and throw up flames of smoke and shoot out red-hot stones and mud called lava. Streams of lava run down the mountain-side and afterwards cool down into hardened masses of mud. That piece of pumice-stone which you use to get inkstains off your fingers, which is full of little hollows and cells like a thimble, and is so light that it will float in your basin of water, is just a bit of hardened lava from a volcano. You have seen slag from a furnace, and you remember that it is also full of pits and cells formed by fire, like a piece of bread which is full of holes.

HEAT IN THE INTERIOR OF THE EARTH.—These outbursts from volcanoes show that there is great heat inside the earth, under its thin outside crust of rock and mud, just as we found a hot steaming mass of apple inside our tart under its thin crust of pastry. Now it is thought that in the past ages of the earth's history, fire and heat inside the earth caused rocks and mountains to be pushed or pressed up from its surface; at first their atoms may have been red hot, but gradually they cooled down, and crystallised, that is formed them-

selves into crystal-shaped morsels, all joined together into what learned people call "crystalline rocks."

SLATE.—Some slates come from clay, but there are others which are thought to be simply dust from volcanoes, pressed into a solid mass.

IRON.—When you see a red, brown or yellow colour in rocks and stones it often means that there is iron in them. You know that iron is one of the most useful of metals, and fortunately for us it is found throughout the world. We hardly ever find it pure, but it is dug out of rough ores and rocks, deep down under the earth. It is a good thing that the beds of iron are not on the surface, for had they been exposed to the weather the iron must have been all crumbled or washed away by degrees. There are great beds of the most valuable kind of iron ore in Sweden, Canada and the United States; and in our own country some of the largest are in Lancashire and Cumberland. When iron is mixed with carbon it becomes still harder and forms steel for swords, knives, scissors, etc.

FLINT AND QUARTZ.—One of the most common minerals which we find in the roads in stones is flint; another is quartz. You may often come across these two mixed together in one stone. Many flint stones have been slowly formed around little soft sponge-like animals of long ago. Sandstone, which is really sand hardened and pressed together, is chiefly formed of quartz grains.

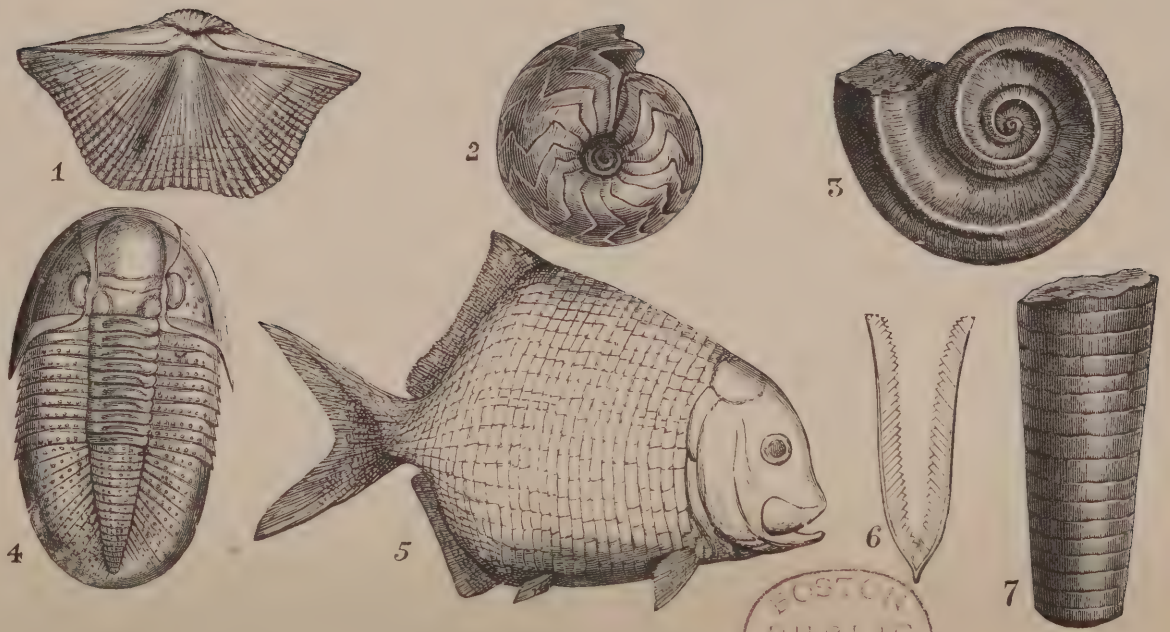
COAL.—You know, I daresay, that coal is made up of plants, probably chiefly great club mosses and horsetails and tall ferns which grew in the forests of thousands of years ago, and which through the long centuries became pressed down, sunk under the sea and raised again, buried perhaps under sand and mud, and at last hardened and pressed together into the coal which we burn on our fires to-day. In Ireland and

Scotland too, what once were shallow lakes have been turned into peat bogs by the massing together of bog mosses ; and these blocks of peat are burnt on the Irish fires as coal is burnt in England.

SOIL.—You know what a difference there is in soils, and how some soils are much more fertile than others? The rock from which the soil comes has a great deal to do with this. Granite for instance is unfertile, because it is made up of quartz, potash-felspar and mica ; quartz cannot be melted by water, so plants do not grow well upon it, for they cannot feed on minerals which have not been broken up and dissolved in water, as a lump of sugar is melted in a cup of tea. If the granite rock becomes broken up and crumbled by the weather, and if the mica and felspar are thus opened out to the air, they will dissolve and make good fertile soil.

A CIRCULAR HISTORY.—It is curious to think what a strange history some of these stones may have had. Once upon a time a stone was ground down into earth, that soil helped to feed a plant, the plant fed an animal, the animal died and crumbled into the earth, and through the long years this soil was gradually pressed together and turned into rock and stone again.

FOSSILS.—We might go and hunt in the old quarry for fossils. These are always interesting, for when we find a fossil skeleton or cast in a rock, it tells us something about what was growing and living on the earth or in the sea at the time that particular rock was formed. In rocks now well inland, as for instance in some kinds of limestone, we find fossils of fish, sea-shells, corals, and other sea creatures, and fossil joints of "stone-lilies," which point to those rocks having been in past ages under the sea. Again, we discover traces of great tracts of land—stumps of fossil trees,



CHARACTERISTIC PALÆOZOIC FOSSILS.

1. *Spirifer striata*, a brachiopod. 2. *Goniatites Listeri*, a cephalopod. 3. *Enomphalus pentangulatus*, a gastropod.
4. *Phillipsia gemmulifera*, a trilobite. 5. *Platysomus striatus*, a Peruvian ganoid fish (restored).
6. *Didymograptus Murchisoni*, a graptolite 7. *Orthoceras undulatum*, a cephalopod.

remains of lizards and land snails, etc.—even rain prints, and stones with rippled marks where the rain of past ages marked and scored them while they were still soft!

SERMONS IN STONES.—If we want to find "sermons in stones," we may think over those animals

Loaf-Shaped Fossil.

and plants of long, long ago leaving their traces in the rocks to this day, and resolve that we too will leave our record behind us! Let us live such lives that we may leave for those who follow us a good example of holiness, truth and courage,

"And departing leave behind us
Footprints on the sands of time:

Footprints that perhaps another,
Sailing o'er life's solemn main,
A forlorn and shipwrecked brother,
Seeing, shall take heart again."

Questions

1. Of what is the crust of the earth made?
2. What is mud?
3. How was limestone rock built up?
4. How have stones been scattered over the earth?
5. What is chalk made of?
6. What is pumice stone?
7. How do we know that there is great heat inside the earth?
8. How was granite formed?
9. What is steel?
10. What is sandstone?
11. Of what is granite rock composed, and what must happen before it can make fertile soil?
12. How could a stone be changed, feed a plant and an animal, and then change back into a stone again?
13. What is often proved by fossils in rocks?

DECEMBER 1

Little Farmers

LITTLE THINGS.—Have you ever thought how many great events in the world are brought about by small things? A big town may be set on fire by a tiny spark. A man may be stirred to do a very good deed or a very bad one by a few little words. Shakespeare says,—

> "He that of greatest works is finisher
> Oft does them by the weakest minister."

EARTHWORMS.—I want you to come out with me to-day to see a very great work being carried on by some common little animals which perhaps till now you may have despised and looked down upon, or at anyrate only thought of as bait for fishing! As there is no frost the ground is soft, and here are some signs of the work.

Why, these worm castings which look like little ropes of sand! Of what good are they? Very great good, as I am going to tell you presently.

WORMS AS PLOUGHSHARES.—Look at that great brown field on the other side of the hedge. You tell me it is a ploughed field—and how was it worked? Why, by a plough of course. And a man had to work the plough? Certainly; it could not work of itself. Yes, long ago in the world's history men found out that land must be ploughed if it was to yield crops. But will you be surprised to hear that land was ploughed long before human beings ever invented ploughing instruments, and is still, in places where men's tools never work? These wonderful ploughers are simply our humble little earthworms, and the castings are signs of their important labours.

WORMS-BURROWS.—You know that however deep down you may dig in your garden, you can never get too deep for the worms; you may turn them up at any depth. They will burrow from 7 inches to 4 or even 6 feet, and there they are, always digging, ploughing, burrowing, making channels for water and air to pass, opening passages for roots of plants to creep through, turning the soil over and over and manuring it, making their numberless castings, even in some places changing the nature of the ground in the course of time. They form their tunnels chiefly by swallowing earth, getting out of it any nourishing matter, and casting out the rest, so that they are always bringing fresh soil to the top.

DEPTH OF SOIL CAST UP.—It has been calculated that in the eight and a half centuries since the Norman Conquest, the surface soil of English meadows, to a depth of 8 or 9 inches, must have been eight times swallowed by worms and thrown out in their castings. It is said that they bring from 10 to 15 tons of mould an acre to the top every year. When we look at a nice piece of smooth turf we may remember that worms have helped to make the land beneath it smooth and even, by levelling the rough uneven parts.

LEAVES DRAGGED DOWN.—And they are good farmers and gardeners in another way also. They help to make the soil better with the leaves which they drag down into their holes. It is very curious to watch a worm getting a leaf into its tunnel. It has no eyes, though it can just tell light from darkness; so it cannot see what the leaf is like, it can only tell its shape, as a blind man would, by touch. As with most blind people, its sense of touch is very keen. So you may see it feeling round the leaf, and then pulling it down into the hole, generally with the point downwards. And it plugs up the mouth of its tunnels also with leaves or sticks or little stones, probably in order to keep out the cold or too much rain, and perhaps also to keep itself safer. It often swallows leaves, and seems specially fond of those of carrot, onion and primrose. It drags down seeds too into its holes, most commonly those of the ash and sycamore, which it can grasp easily by their "wings," and often the seeds grow which are thus planted by this queer little gardener.

SENSES OF WORMS.—As it is so blind, if you carry a worm an inch or two from its burrow it does not seem able to find its way home again, but will have to make a new one. It is deaf, as you can prove by whistling or shouting near it, and it will not take alarm, so long as you do not allow your breath to touch it; but it feels vibrations and tremblings in any solid substance

very quickly, even, it has been said, those of the thrush's foot, when its thrush enemy is approaching. If you bury an onion with a worm in a tub of earth, the worm seems able to smell it out, thus showing that it has apparently a slight sense of smell. If you put a few large flat stones at the top of the earth, the worm will bury them, by constantly turning over the soil near them, and casting it up around them. Ancient remains of interesting buildings, old Roman pavements, etc., have been preserved under the ground by the workings of worms, which have covered them over and buried them. And the worm lines its little parlour at the end of its tunnel with small stones, to keep its body dry in the damp, cold earth.

STRUCTURE OF WORMS.—What a strange creature the worm is, with no eyes, no nose, no ears, no teeth, no jaws, and yet ever carrying on these immense labours! It is made up, as you know, of a number of rings, from 100 to 200, which it can draw together and pull out again like a wire spring. Underneath there are tiny bristles, eight on each ring, to catch hold firmly of the ground as it moves along.

In its tunnels there are little knobs sticking out here and there, which serve as rests for its bristles when it passes up and down them. It does all its burrowing work at night.

Moles feed on worms.

MOUTH.—The worm's mouth has a little lobe or lip, and behind it a kind of trunk or proboscis which can be pushed forwards and backwards, and which the worm uses in eating, touching, catching hold of things, and in burrowing.

INTERNAL ORGANS.—Its food is ground in its gizzard by strong muscles, with the help of sand and small stones, rather as corn is ground between millstones. It has a long, curiously arranged digestive tube, blood

vessels, and a system of nerves. You can see the red blood shining through the skin of a living worm, and flowing backwards and forwards. So although it is so simply made I think it must be able to feel pain to a certain extent. I have read that the good and learned Bishop Harold Browne of Winchester stopped a whole procession of clergy as he was coming out of a church after a Confirmation, that he might stoop to pick up a worm which was crawling along the path and place it in safety on the grass by the roadside.

HAIR-WORMS.—There are many and various kinds of worms. I daresay you have sometimes seen the

Sea-Mouse.

strange hair worms which look just like very long hairs or threads. Many of them curl and wriggle about in dirty water, old vinegar and decaying stuff, where they feed on the fungi contained in it. There are worms which live in the sea, and are furnished with quantities of bristles.

THE SEA-MOUSE.—One sea worm called the sea-mouse [1] is rather like a slug in shape; it is common on the coast. Its sides have most beautiful hairs, which shine with constantly changing colours, like those of humming birds, and its bristles are like barbed spines,

[1] Aphrodite aculeata.

to push in and out, and to keep it safe from the attacks of fish. The porcupine sea-mouse [1] is so called because it bristles with spines like perfect harpoons, more formidable indeed than a porcupine's. The barbs have sheaths, so that the worm does not tear its own flesh when it pushes them in and out. It likes to hide under stones or shells in the day-time.

SERPULA.—If you have spent a day at the seaside you must have seen stones, shells, etc., covered with little white pipes, like boiled macaroni? Perhaps you find one with a little red showing inside. Put the pipe in a basin of sea water, and presently (perhaps after two or three hours) out will come, very slowly, the head of a long worm called a serpula.[2] You will see his breathing organs on his neck—beautiful scarlet feathery gills shaped like a fan. If you make the slightest movement he will draw his head into the tube again—quick as a flash of lightning—and you will find he shuts himself in with one of his tentacles or feelers, which just fits the mouth of the tube as if it were the stopper of a bottle or a tiny trap-door. He also has a wonderful arrangement of hooks or bristles, comb-like plates, only to be seen in a microscope, to make him able to draw back quickly into his home.

SANDWORM.—The very common lob-worm or sand-worm [3] has his scarlet feathery gills in the middle part of his body. He burrows in the sand, just as the earthworm buries itself in the earth, boring tunnels; and as the earthworm swallows earth, so he swallows sand, takes out any nourishing stuff to be found in it, and then leaves it again in little heaps or sand castings on the shore.

RIBBON-WORM.—Perhaps the most wonderful of the sea worms are the ribbon-worms [4] which swim in the

[1] Aphrodite hystricella.
[2] Serpula corntortuplicata.
[3] Arenicola.
[4] Nemertes.

sea and which really might be taken for small sea serpents! They can stretch themselves out to be 30 or even 40 feet long, and then shorten themselves to 3 or 4 feet. They will writhe themselves up into knots or into a twisted corkscrew shape. This strange creature has a long lip or proboscis which it can push out 8 inches and then pull back again. The young ribbon-worms are not in the least like their parents, but twirl about in the water, shaped rather like a policeman's helmet, with long waving hairs with which they catch their food.

We have left many other kinds of very curious worms unnamed, but I hope you will agree that our little humble earthworm belongs to a very large and interesting race.

Questions

1. How do earthworms form their tunnels?
2. What good do they do to the soil?
3. How do they help to manure the ground?
4. What senses does a worm possess, and which sense is the keenest?
5. What is its mouth like?
6. Why is it probable that it can feel pain to a certain extent?
7. Where do you see hair worms?
8. Describe a sea mouse?
9. How does a serpula shut itself into its tube?
10. What is the length of a ribbon worm?

DECEMBER 15

What will the Weather be?

WHAT IS THE WIND?—Our Nature lessons have been about objects which we can see, but we will think to-day about something which we cannot see, though we can feel and hear it, and often can know where it has been by the traces it leaves behind. Can you guess what this is? Why, the wind.

What is wind? Just moving air.

THE ATMOSPHERE.—Wind shows that there is an envelope or covering of air all around the earth, which we call the "atmosphere." We can tell this also by the flight of birds which sail along through air high up over our heads. The atmosphere is thought to reach to a height of 45 miles above the earth. It is supposed that shooting stars can be seen at a height of 90 to 130 miles, and that when they strike against our atmosphere they become white hot and then go out like a candle and we see them no more.

PRESSURE.—Now let us think how the air is set going. Air is always pressing upon the earth—15 lbs. of air to the square inch. We do not feel it pressing upon our bodies and weighing them down because there is air inside our bodies too, which counterbalances (or weighs against) the air outside. But if we climbed up a very high mountain, or went up in a balloon, we should find the air becoming lighter the higher we mounted, because it becomes less in the higher regions; then the air inside our bodies would press outwards, being heavier than the air outside, and we should feel

as if we were going to burst, and might bleed from the nose and ears.

You can see for yourselves something of the pressure of air, in a very simple way. Fill a tumbler quite full of water, put a flat piece of paper over the top of the tumbler and turn it upside down; the water will not spill because the paper will keep it in its place, and the paper will not fall off because no air has got inside the glass and the air outside presses upwards against the paper and holds it firmly against the tumbler.

HEATED AIR.—Now when any portion of air becomes hotter than another, it gets lighter and rises, as we saw in our lesson on clouds. And as soon as some of the air near the ground rises and goes away from any part, a colder heavier current or draught of air rushes in to take its place, and so the air is set in motion, and a wind is caused.

You can see that hot air rises if you watch a piece of paper which has been thrown on to the top of a fire; a draught of heated air is flowing up the chimney and quickly carries the paper with it.

Then leave the fireplace and put your hand close to the chink at the bottom of the door, which is shut; you will feel the cold air rushing in from outside, to take the place of the air in the room which has been heated by the fire and is going up the chimney and towards the ceiling.

SEA BREEZE.—If you are staying at the seaside you will find in fine weather a sea breeze blowing during the day, for the land is heated by the sun, the air rises, and the colder heavier air comes in from the sea to take its place; but at night the land becomes colder than the sea, and then a land breeze blows, for the colder air flows from the land seawards.

> "But God hath willed that the sky-born breeze
> In the centre of the loneliest seas
> Should ever sport and play."

LAWS OF THE WIND.—We are apt to think of the wind as very irregular and uncertain, following no fixed laws, and yet we find it is generally inclined to veer round according to the sun, from north to south by the east, and back to north through west. If it changes in the opposite direction it is said to "back." Of course the regular trade winds always follow the same line; in the northern hemisphere from north-east to south-west; in the southern from south-east to north-west, for thirty degrees latitude above and below the Equator.

POINTS OF THE COMPASS.—In a mariner's compass you will find thirty-two points marked from which wind may blow, but its eight chief directions are, north, north-east, east, south-east, south, south-west, west, north-west.

WINDS IN ENGLAND.—The winds which blow most often in England are south-west and north-east. Although Christmas will soon be here it is not cold to-day, because a west-south-west wind is blowing from the warm Atlantic, but it will probably bring rain before the day is over; for it will mix with the colder, dryer air, and being chilled, will "condense" into clouds the vapour which it has brought over from the sea. Last week, you remember, we had cold weather, and it was very dry, for there was a sharp cutting north-east wind. The north-east wind was dry because all its moisture had been taken out of it as snow or rain, further north, where the air was colder. Then, coming to warmer regions, it expanded and spread itself out and picked up all the moisture that it could, but it had none to spare for rain making.

POLAR AND EQUATORIAL CURRENTS OF AIR.—Our school globe shows the shape of the earth to be like that of an orange, narrower at its poles than in its middle or equator. The heated air from the tropics

rushes as an upper current towards the colder poles, and the cold air at the poles as an under current towards the hot tropics. But, as you know, the earth is spinning round all the time like a top, and as these winds go along with it they cannot blow quite straight. Near the Equator, the air moves much faster than near the poles—about 1000 miles an hour—because it has to cover a much greater circle. And when the faster and slower currents meet, they are set spinning round and round, sometimes from right to left, sometimes from left to right.

DIRECTIONS OF CYCLONES.—The stormy wind called a cyclone generally whirls round in the direction which is against the hands of a clock; the opposite current, called an anticyclone, which brings fine dry weather, moves with the hands of the clock.

WEATHER FORECASTS.—The people who forecast the weather for the British daily papers receive telegrams from all parts of the world with news of the state of the wind, and the rise and fall of the barometer or weather glass; in the barometer the air presses the quicksilver upwards and downwards, and so the weight of the air is measured. The weather-prophets bring together these different accounts, and from them sum up what our weather is likely to be during the coming twenty-four hours.

Even in olden times there were weather prophets. The Italian castles on the shores of the Adriatic had bastions with pointed rods; the guards on duty touched these rods with the iron points of their spears, and if they saw an electric spark pass they rang an alarm bell to warn the fishermen of a coming storm. This plan was followed in many other parts of the world.

WEATHER SIGNS.—Of course there are some different weather signs in different parts of the country,

and winds and weather vary locally according to local hills or lakes or sea-coasts. A hill may gather clouds, or the wind may pick up water from a lake, and bring down rain in one place, while it might be quite fine and dry in another part a few miles away.

SPEED OF WINDS.—The rate at which winds blow can be measured, partly by observing a cloud blown along by the wind over a field or any other particular space of ground. A gentle wind moves from 5 to 10 miles an hour, a moderate breeze from 12 to 15, a strong breeze from 20 to 50, a gale from 40 to 70, a storm from 70 to 85, a hurricane from 100 to 150, a tornado at about 200 miles an hour.

THE WIND AND THE SPIRIT.—Our Lord drew for us a lesson from the wind. "The wind bloweth where it listeth, and thou hearest the voice thereof, but knowest not whence it cometh, and whither it goeth: so is everyone that is born of the Spirit." The Greek word for "breath" and "wind" is the same. As breath gives life to the body, we know not how, so the Holy Spirit gives the breath of a new life to the soul.

Questions

1. What is wind?
2. How can we tell that there is an atmosphere round the earth?
3. How is it that the air presses upon our bodies and yet does not weigh us down?
4. What happens to heated air?
5. What is a sea breeze?
6. What makes a north-east wind dry and cold?

7. Why do winds travel faster at the Equator than the poles, and what happens when the polar and equatorial currents meet?
8. What do the weather prophets study in order to forecast the weather?
9. What is the rate of motion of a gentle wind, and of a tornado?

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